Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPARTMENT

JUNE, 1959

vol 36 #6.

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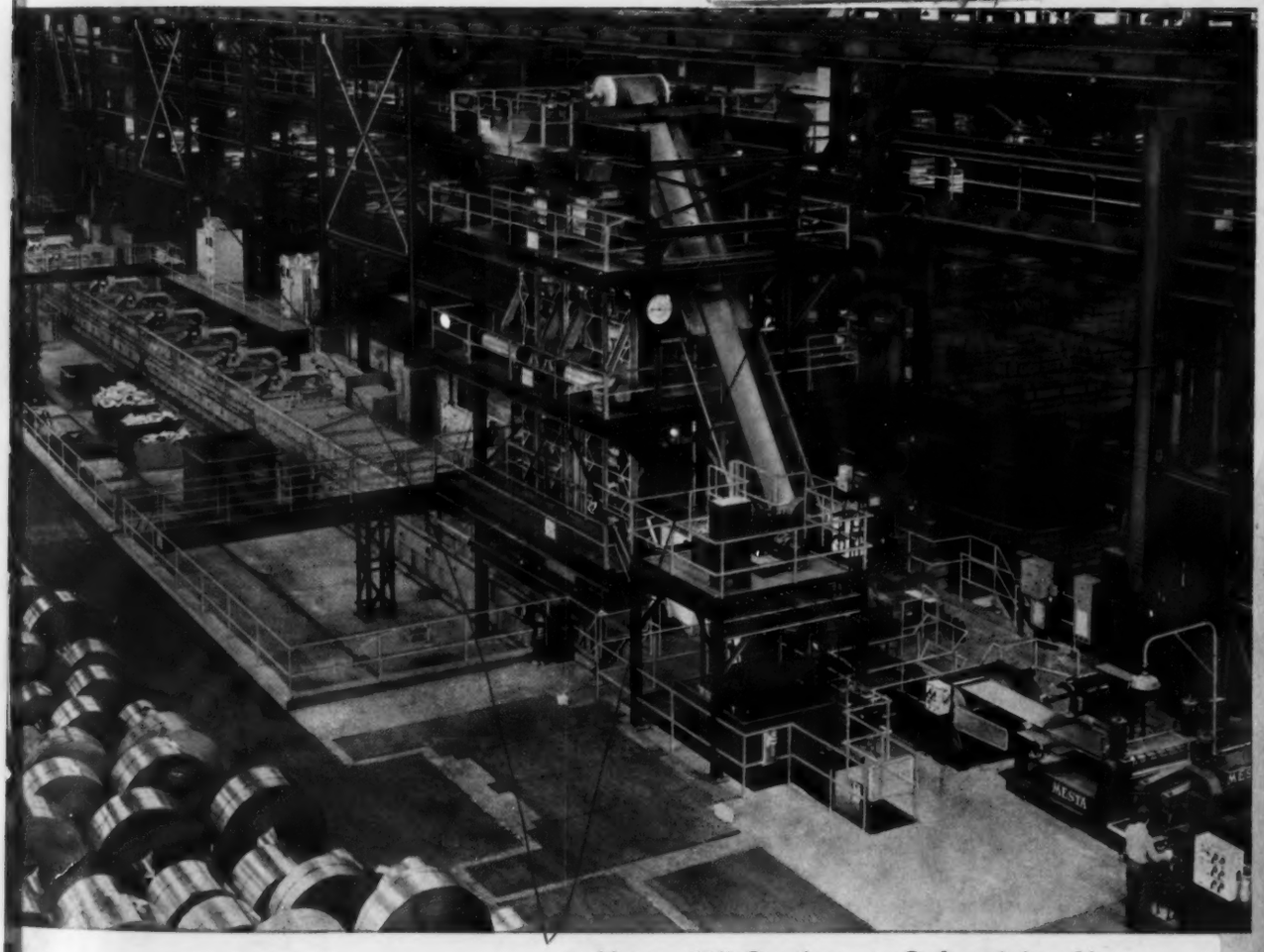
DETROIT

Continuous galvanizing lines

Designed and Built by MESTA

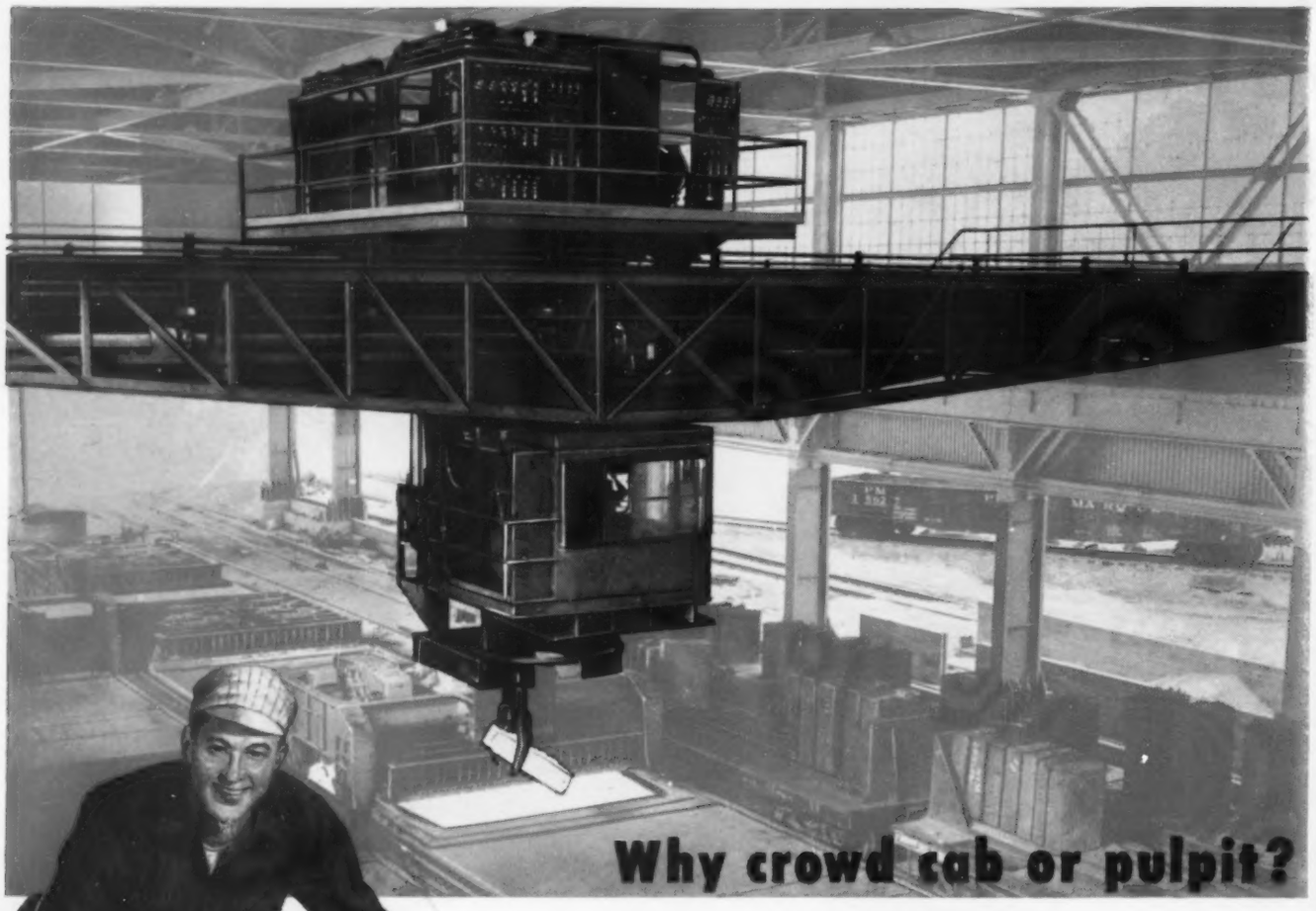


Mesta 48" Continuous Galvanizing Line

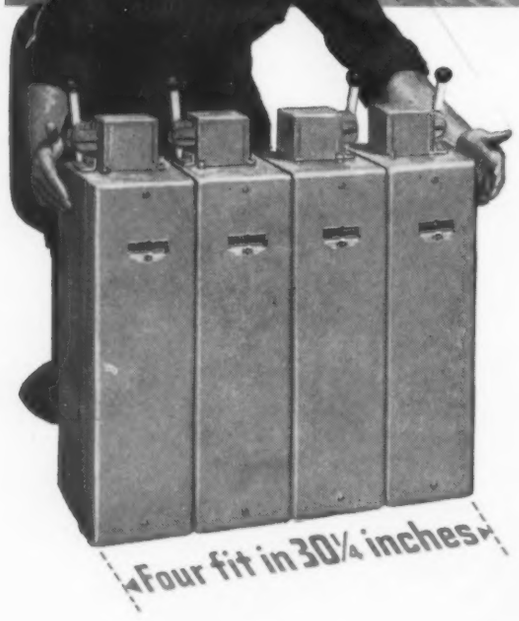
Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

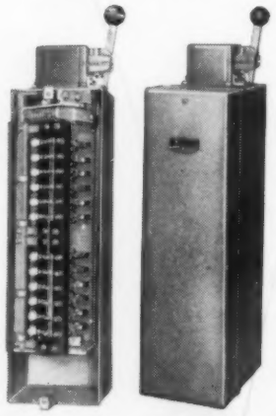


Why crowd cab or pulpit?



Use the "THIN" Master

The Cutler-Hammer 14951 Type D Master Switch is designed especially for crane cab and mill pulpit use where space is at a premium and dependable "pin-point" control is so necessary. Compact in design yet so easy to install and service. The Cutler-Hammer "Thin" Master employs the basic principles of design and construction that have been tested and proved over many years of service in the metal working and allied industries. Save space . . . save installation and wiring costs . . . save operator fatigue. Specify Cutler-Hammer Thin Masters for precise control, dependable control. For detailed information, write for Bulletin 14951-L-232 Cutler-Hammer Inc., Milwaukee 1, Wis.



- Compact in design . . . only 7⅝" wide
- Lever head can be rotated in 90° steps for greater operator efficiency
- Available with or without "Off" position latch
- Adjustable lever tension for improved operator "feel"
- Available in 6, 12, and 16 circuits with up to 6 speed points in each direction
- Choose the enclosed type for base or wall mounting, or the open type for benchboard installation
- Double break silver to silver vertical contacts individually removable

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

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LIGHT GAUGES

at High Speeds

Need Rugged

Equipment

Each step toward paper-thin tin plate accentuates the operating problem. Tracking becomes more acute as speeds increase. Coils increase in diameter and weight. Tension becomes more critical.

Only rugged machinery, for which Aetna-Standard is noted, can stand up to 21-turn operation at high speeds with a minimum of strip breakage, down time and maintenance.

BLAW-KNOX COMPANY
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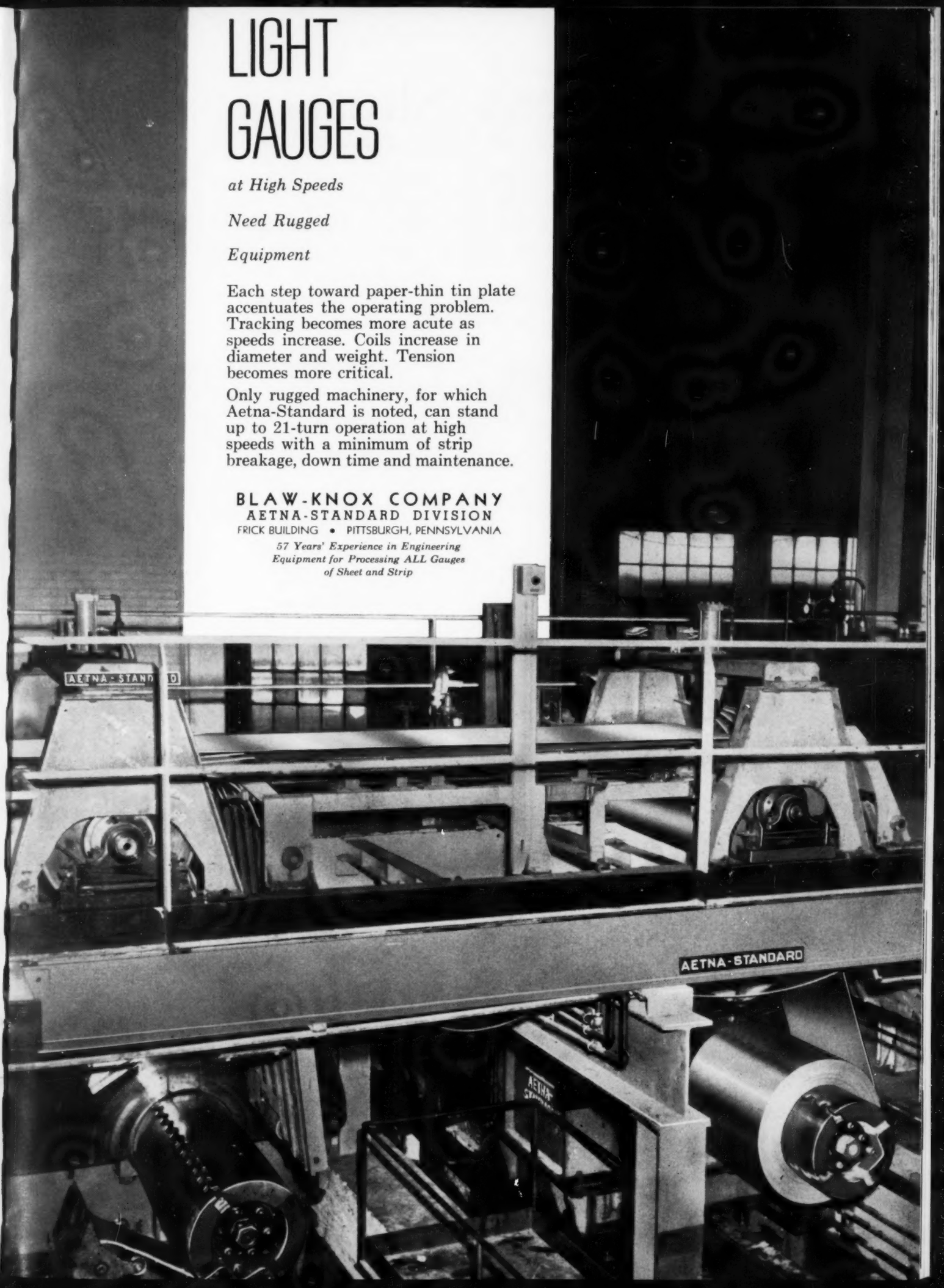
57 Years' Experience in Engineering Equipment for Processing ALL Gauges of Sheet and Strip



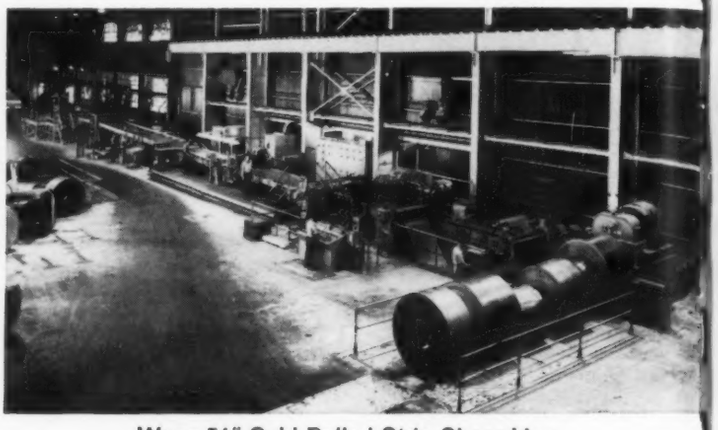
Rugged Wean Shearing Lines

Wean Shearing Lines are designed and built to perform at high speeds without loss of accuracy. This combination permits large production quotas to be met with no sacrifice of quality.

Designed to meet customer requirements, Wean Shearing Lines may provide versatile combinations of shearing, slitting, edge trimming, recoiling and temper passing to produce sheets in a wide range of sizes and gauges.

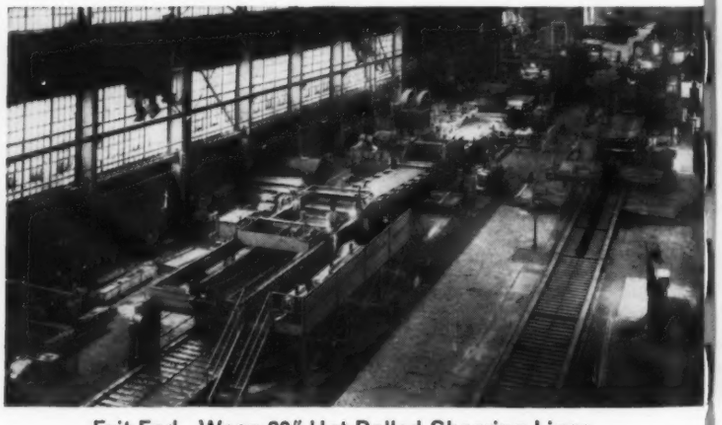
If you are planning to expand or modernize your hot or cold rolled strip shearing facilities, Wean's *creative engineering* can mean important savings to you.

Wean 80" Cold Rolled Strip Shear Line.



Wean 54" Cold Rolled Strip Shear Line.

Two Wean 80" Hot Rolled Strip Shearing Lines with McKay Processing Uncoilers.



Exit End—Wean 80" Hot Rolled Shearing Lines (Flying Shear—left; Up-Cut Shear—right).

Specialists in the design and construction of sheet, strip and tin plate processing lines . . .

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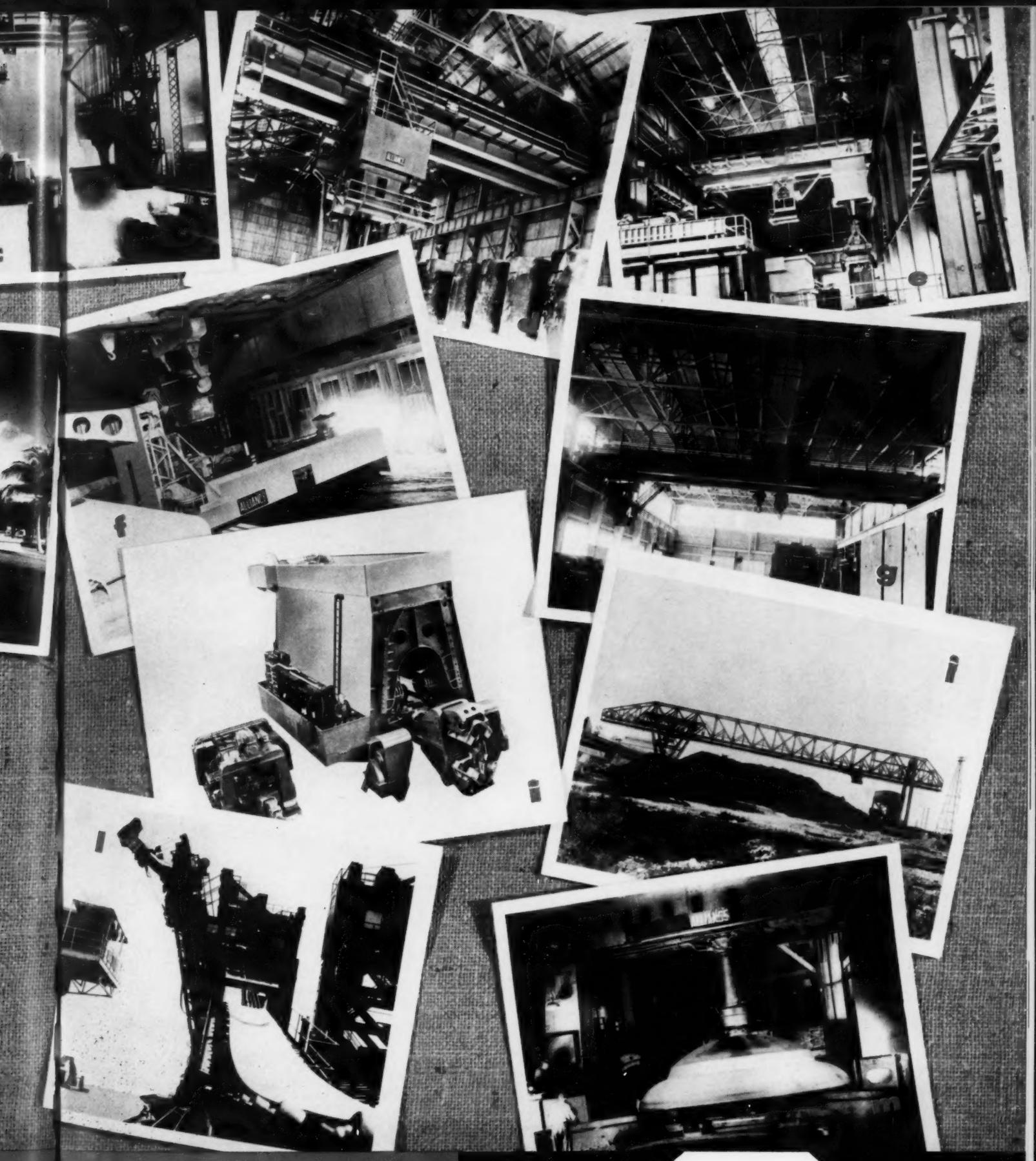

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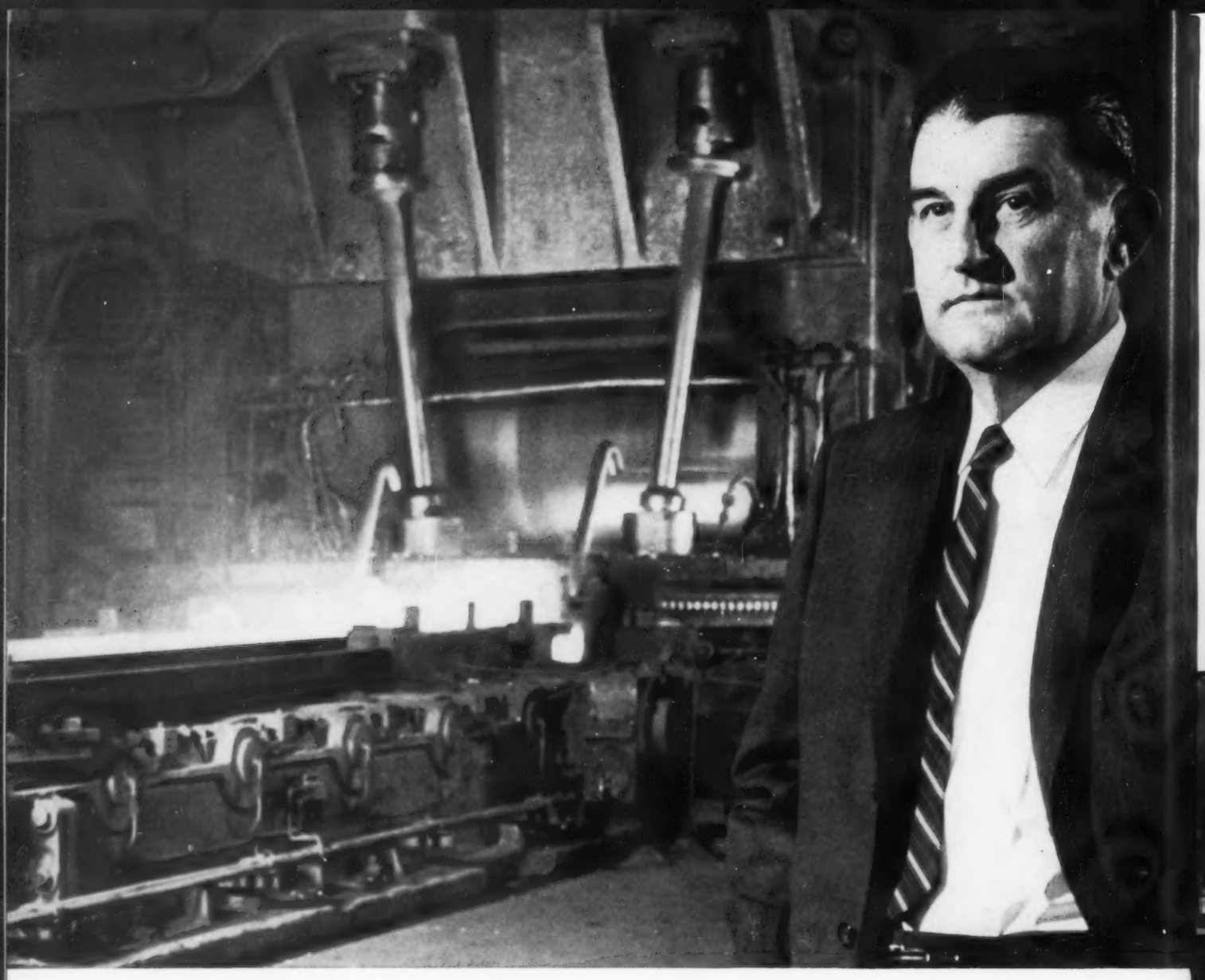
Give us the Runway... and We'll Lift the World

the Alliance machine company

Main Office Alliance, Ohio



"Steel roll users like the complete service National gives them"

says Deac Scholl, manager of roll sales

"The new building, new equipment and new processes included in the expansion of National's roll-making facilities have resulted in a more complete line of longer-life steel rolls for our increasing number of steel roll customers.

"The expansion embraces all phases of production from pouring to machining. For instance . . . with the new facilities, including the newest type electric furnaces, we can now pour and machine steel rolls, both plain and grooved, in a wide range of sizes.

"And in addition, we have increased sales and service personnel, so we can give you, as never before, in-plant attention to your roll problems.

"Our staff members have had years of experience in the roll, steel foundry, and other metallurgical fields. They are well aware of the many metallurgical and rolling problems that occur; and recognize that selection of the correct roll—whether iron, nodular iron, or steel—can be of extreme importance.

"Let us study your problem and give you our recommendations for its solution."

GENERAL STEEL CASTINGS

National Roll & Foundry Division

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.

Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

47th

LEE WILSON SINGLE STACK GOES "ON STREAM" AT McLOUTH

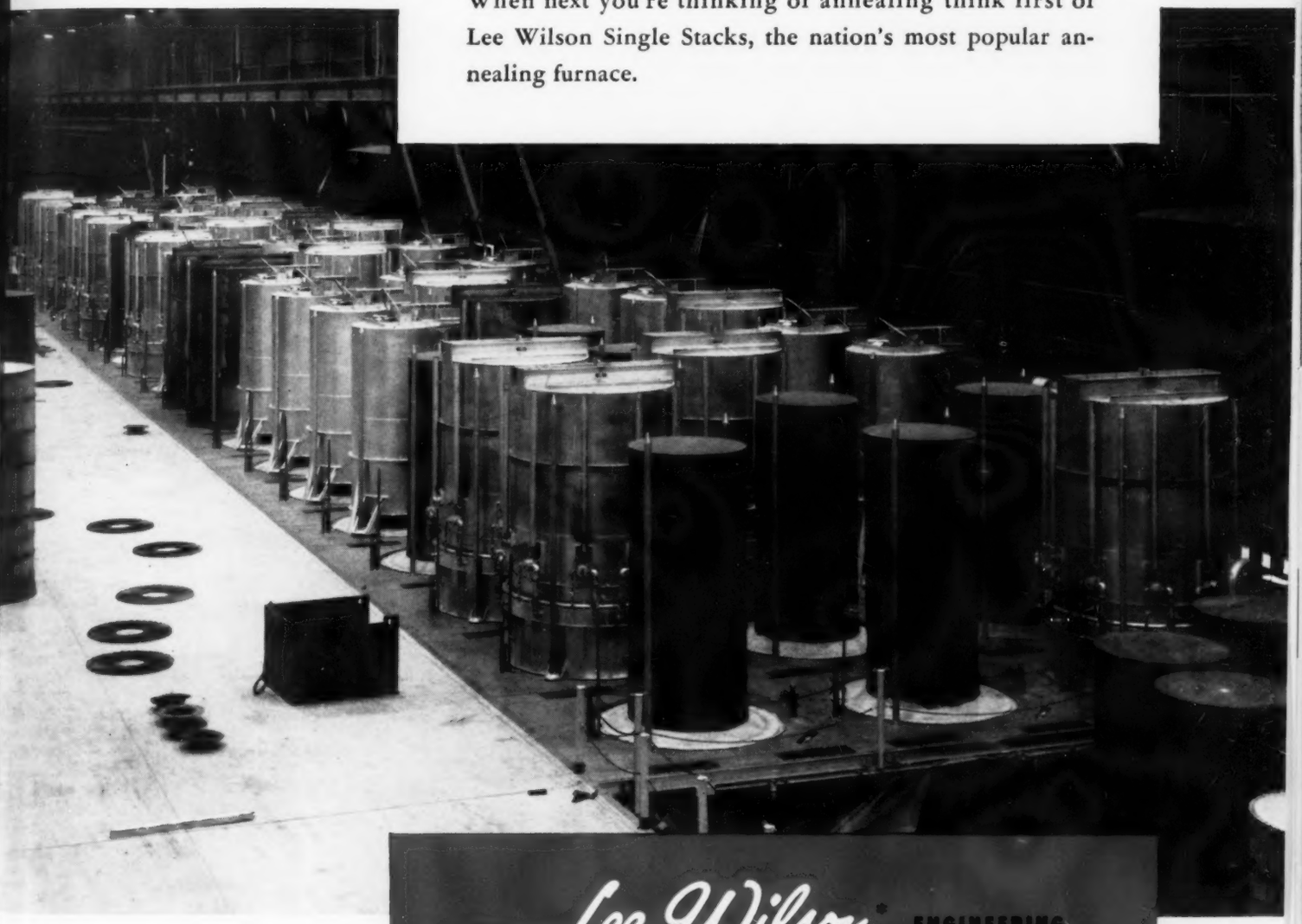
Progressive Producer Has Industry's Largest Single Stack Annealing Furnace Installation

When McLouth Steel recently put their 47th Lee Wilson Single Stack Furnace "on stream" they set into operation the industry's largest Single Stack operation.

But more important, this gives McLouth one of the most accurate, most versatile high production annealing departments in the world. For only Lee Wilson's exclusive "O" tube—high convection design distributes the heat with exacting uniformity. And, by heating the stacks individually, each charge can be individually controlled for greatest flexibility.

The installation, made over the past four years, is of 60″ diameter furnaces with 162″ piling heights.

When next you're thinking of annealing think first of Lee Wilson Single Stacks, the nation's most popular annealing furnace.



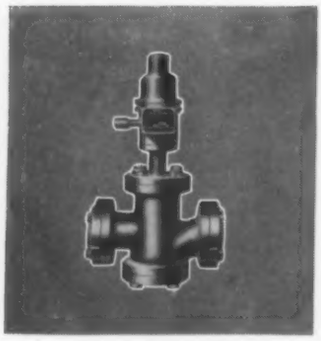
Lee Wilson® ENGINEERING COMPANY, INC.

HIGH PRODUCTION ANNEALING SYSTEMS

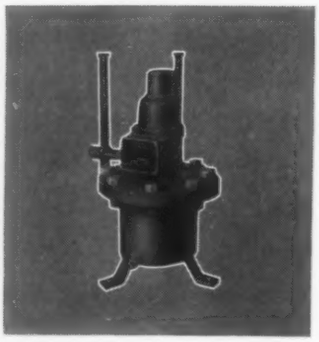
MAKE THE BEST METALS BETTER

The large scale of the *ElectroniK* flow meter is easily readable at great distance. Flow, regardless of the fuel used, is recorded on an evenly-graduated chart. Functions of measurement, integration, control, retransmission, and remote set point adjustment can all be incorporated in this single instrument.

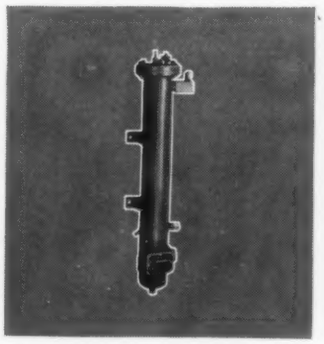
use these accessories with the *ElectroniK* flow meter . . .



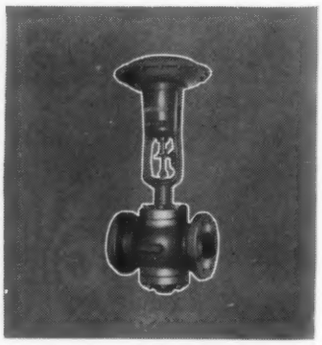
Area type electric flow transmitter for measurement of the flow of oil, tar or pitch.



Ledoux bell type electric meter body for measurement of atomizing steam flow.

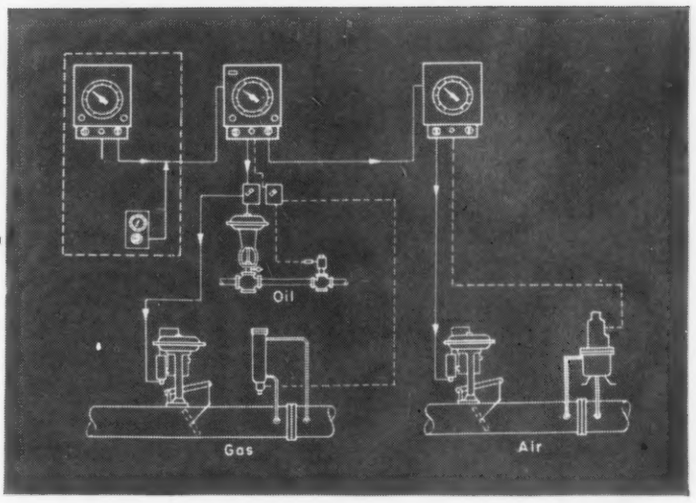


Bell type electric meter body is ideal for the measurement of air or gas flow.



Honeywell diaphragm control valves for control of fuel, air and steam flows.

Typical control system using *ElectroniK* flow meters for automatic Btu input on basis of temperature requirements.



ElectroniK flow meter lets you switch fuels without upsetting fuel-air ratio

...records, indicates, integrates, controls and transmits

Use the highly versatile, accurate *ElectroniK* flow meter to save fuel dollars and improve operating efficiency in combined fuel systems. It's calibrated for both gas flow and equivalent oil flow, and automatically proportions the input of each type of fuel on the basis of total Btu input at the furnace.

The *ElectroniK* flow meter operates on the induction bridge principle, for highest accuracy. For freedom from vibration effects, pen and pointer are positioned by the dependable Brown balancing motor and amplifier used in all *ElectroniK* instruments.

The meter can be supplied with an adjustable *Indexet* unit by which the set point can be established from a remote point—manually, by a pneumatic loading station, or automatically, by another instrument. *Indexet* also provides the wide span and zero adjustments needed to "tune" the instrument to the process with extreme precision.

Other options, such as a re-transmitting slidewire or pneumatic transmission unit, adapt the *ElectroniK* flow meter to a variety of interlocked systems. The flow transmission system permits remote location of the meter.

Get complete details from your nearby Honeywell field engineer. Call him today.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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H HONEYWELL *First in Control*

Cleveland Cranes
FOR
STEEL MILL SERVICE
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OHIO

Crops *and* Shorts

Δ The growth of oxygen converter steelmaking is approaching the spectacular. Experimental work began at the Voest Iron and Steel Works in Linz, Austria, in 1946. The first test run in 1949 produced two tons of steel, and led to the construction of a 15-ton unit. About this time, the Alpine Montan Steel Co. began experiments at its Donawitz plant. A new plant at Voest blew its first heat in November, 1952, and was followed shortly by the Donawitz plant. From this modest start, the process has grown by leaps. Today there are perhaps 75 units in 33 installations in 15 countries operating or under construction, providing an annual capacity of perhaps 18,000,000 tons. It is estimated that by 1965 oxygen steel in the United States will account for 45,000,000 tons per year.

An interesting sidelight is the apparent indifference with which an article on the L-D process was received when published in the Iron and Steel Engineer in March, 1952. There was almost no reaction until 1954, when Dominion Foundries and Steel, Ltd., announced construction of an L-D plant at Hamilton, Canada. Then requests for tear sheets of the 1952 article started to come in. Looks as though it doesn't pay to be too far ahead.

Δ A clipping, source unknown, from a friend tells of an economics student who said: "A recession is a period when sales are down 5 per cent and staff meetings are up 50 per cent."

Δ A correspondent tells us that sleeping outdoors will cure insomnia. So will sleeping indoors.

Δ John F. Smith, Jr., president of Inland Steel Company, believes the Seaway may bring an influx of foreign steel into the Chicago area, which has thus far not experienced this to the extent that coastal areas have. Mr. Smith told Inland stockholders that 1958 imports of reinforcing bars rose 195 per cent from 1957 and equaled 23 per cent of shipments by American companies, whose volume declined 11.5 per cent. He placed imports of nails at 47 per cent of shipments by American companies, compared with 30 per cent in 1957, and added that for both 1958 and 1957 more barbed wire was imported than was produced at home. He said that, in general, there is a 20 to 40 per cent differential between the delivered price for domestic and foreign steel.

Δ On top of this comes word of a three-year contract between a Japanese firm and an American company for shipment of $16,000,000 of Japanese-made ball bearings for the U. S. market.

Also, imports of foreign-built trucks now form about 4 per cent of total U. S. truck sales.

Well, we can keep on shortening working hours and raising wage rates. We'll have more leisure time. We can pay more and more for less and less until. . . !

Δ The Wall Street Journal observes that in the old days, $10.00 worth of groceries would fill a pantry to bursting.

Today, $10.00 worth of groceries won't even burst a shopping bag. Certainly shows how much stronger bags are now, doesn't it?

Δ The Value Line Investment Survey believes that, after a labor dispute that may close steel mills for eight weeks or longer, the steel industry can look for a renewed wave of demand beginning in the fourth quarter of this year. The industry may enjoy the best 12 months in history, with 1960 production possibly reaching a new high of 120,000,000 tons.

The same source feels that the accessibility of foreign iron ore through the St. Lawrence Seaway may hinder the growth rate (not the growth) of the American iron ore industry.

Δ The morning paper says Jimmy Hoffa threatened a nation-wide strike if Congress makes labor unions subject to anti-trust laws. The same paper tells about a 16-year-old boy who killed his mother, father and sister because he was punished for disobedience.

The boy was put in prison for life.

Δ This actual letter didn't come to us but it's typical of some that we get:

"Dear Sir: Last year you printed an article, at least I think it was in your magazine, that interested me very much, but I have forgotten what it was. I lost my notes on the subject and can't find the magazine. Will you send me another copy of same, if it was your magazine?"

The publishing business is full of hazards. The other day an editor dropped six stories into an ash can.

Δ Steelworker chief David J. McDonald says (we won't say "believes") that the issue of inflation is a "fictitious monster" created by the steel industry's "tremendous sales job" in publicity.

Why did Davy have to raise his union's dues?

Δ Just to keep our running commentary on credit cards current:

A group of Seattle restaurants plan to set up their own credit system.

A group of Cleveland restaurants plan to drop out of all credit organizations when their contracts run out.

A new "club" has been organized for cash customers. Members pay $5.00 a year, get a card which entitles them to a 10 per cent discount at more than 2500 restaurants and hotels across the country. This discount will of course have the same effect as credit commissions in raising prices for the poor guy that doesn't want to buy a card but just wants to pay a fair cash price for what he gets.

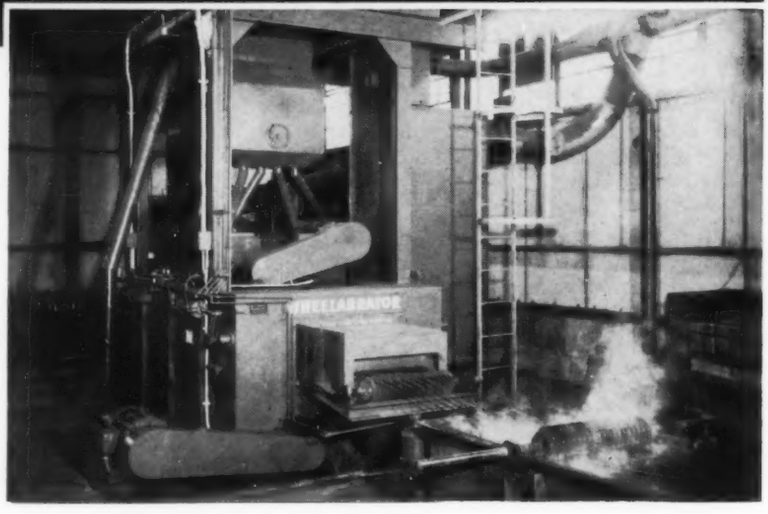
Now comes International Charge, Inc., with a credit card, which banks are encouraged to issue to their qualified depositors. Also, various banks are issuing or considering cards good in their immediate areas.

What good is money, anyway?

FROM HOT ROLLED ROD THROUGH PATENTING, CLEANING AND COATING IN ONE CONTINUOUS OPERATION

THE LESCHEN WIRE ROPE DIV. AUTOMATED STRAIGHT-LINE PRODUCTION METHOD

A. Twelve-strand Payoff Reels.
B. Rod Annealing Furnace.
C. Lead Quench (Patenting).
D. Water Quench.
E. Wheelabrator Abrasive Blast Descaling Cabinet.
F. Borax Coating and Drying.
G. Horizontal Takeup Recoilers.



Leading producers of wire products are now using Wheelabrator® straight-line abrasive blast descaling as the shortest distance between steel rod and wire profits. At H. K. Porter Company, Inc., Leschen Wire Rope Division, St Louis, for example, this process is resulting in exceptional production efficiency and economy.

The automated processing line starts with hot rolled rod, and in one continuous operation produces cleaned and coated rod for subsequent drawing. Wheelabrator mechanical blast descaling is an essential step in this process. It cleans twelve strands at a time in line with patenting, coating and drying and delivers cleaned and coated rod for multiple hole drawing. There is no interruption and no intermediate handling required. Furthermore, the line operates continuously five days a week, 24 hours a day without downtime.

All scale or rust is completely removed down to virgin metal, at speeds required for patenting. The fine matte finish obtained holds a more uniform coating and provides excellent drawing characteristics. This blast descaling process offers freedom from the problems associated with acid pickling. And, through automated production, important additional savings in time and labor costs are achieved by reducing "in process" inventories.

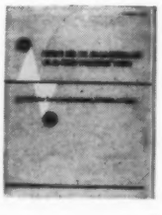
It will pay you to consider this new process for cleaning any type of ferrous or non-ferrous hot rolled rod and bar stock for cold drawn products.

WHEELABRATOR
CORPORATION

396 South Byrkit Street Mishawaka, Indiana
Canadian Offices: Scarborough (Toronto) – Montreal

HOW TO AUTOMATE YOUR WIRE DRAWING LINE

This new booklet explains how Wheelabrator blast descaling can enable automation of your wire production. Write for Bulletin 148-D.



WORLD'S LARGEST MANUFACTURERS OF AIRLESS BLAST CLEANING EQUIPMENT AND STEEL ABRASIVES

Operation Big Squeeze:

World's largest presses lubricated by Cities Service Pacemaker Hydraulic Oils

Once a forging operation for horse-drawn carriages, Wyman-Gordon Company now operates the world's largest presses, with the newest one capable of exerting 50,000 tons pressure.

Reason for this tremendous press is the increasing need for strong, lightweight metal parts for aircraft. Today, as for many years, no military or transport aircraft takes to the air without Wyman-Gordon forgings.

With its huge, hydraulically operated presses, Wyman-Gordon is able to forge huge pieces with one big squeeze. Sometimes a whole unit for a landing-gear strut. Or one mammoth wing spar.

The press that exerts 50,000 tons pressure is described by Wyman-Gordon as "the largest single machine ever conceived"—and few people would argue the point after seeing it.

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Cities Service is justifiably proud that here as in all of Wyman-Gordon's presses with 18,000 tons pressure or better, hydraulic lubrication is provided by Cities Service Pacemaker Oils.

It is hardly necessary to point out the incredible demands that such machinery makes of its hydraulic lubricants... and certainly it is self-evident that if Cities Service Pacemaker Oils can perform satisfactorily in the world's largest presses, they'll do the same for you. Talk with a nearby Cities Service Lubrication Engineer. Or write: Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.

Entire Rig Is Operated by One Man with the few simple controls shown here. With a flick of his fingers he can put on a squeeze of 50,000 tons. Result is extremely strong lightweight forgings for aircraft.

Lubrication Foreman has mammoth responsibility. Here, he checks dispenser for Cities Service EP 20 Lubricant... used on main bed and columns of large presses and other areas subject to extreme pressures.

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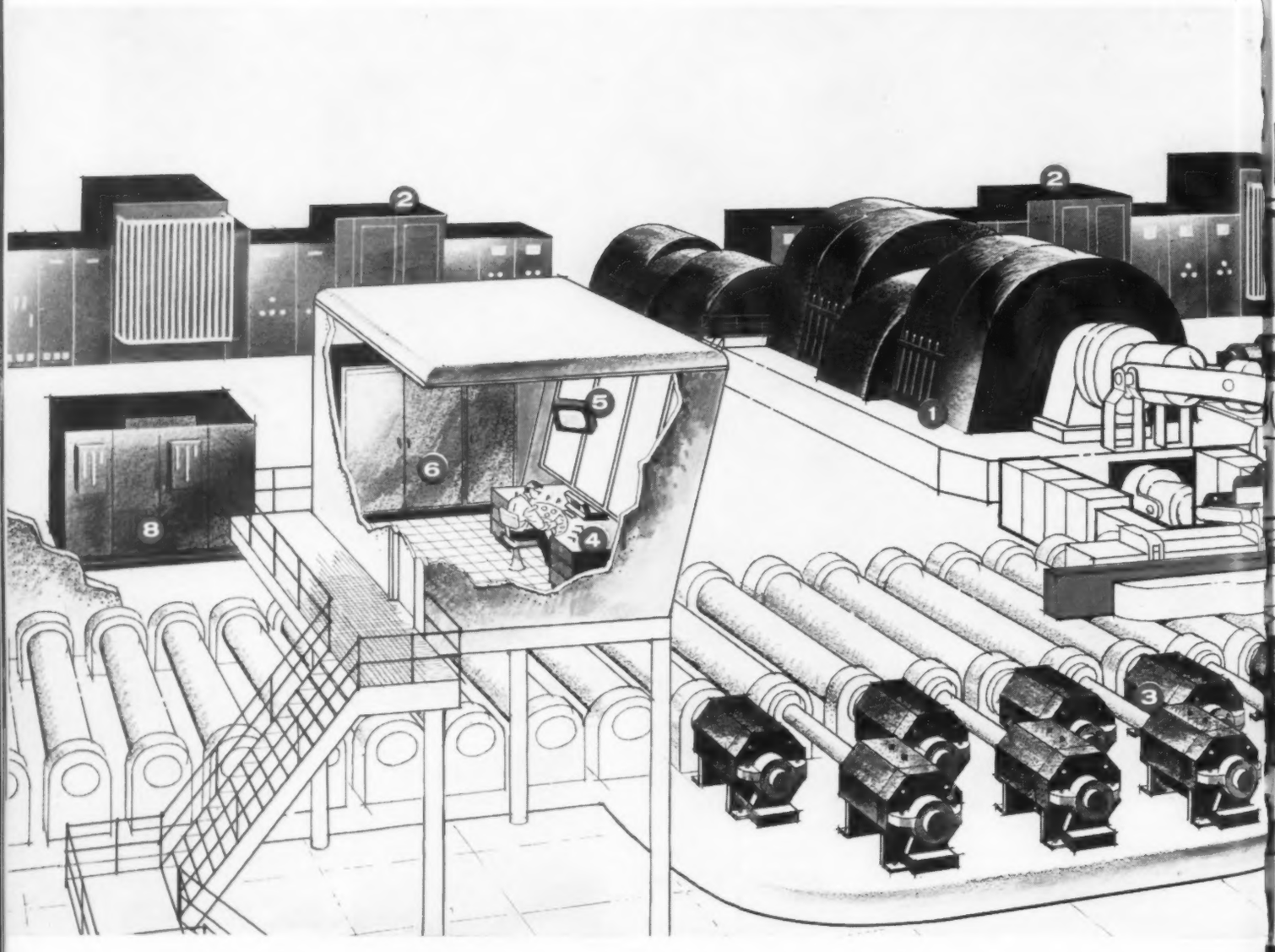

Above is General Electric's version of a completely automated reversing hot mill. While your facility may differ, the products and technology for automation are available from General Electric today.

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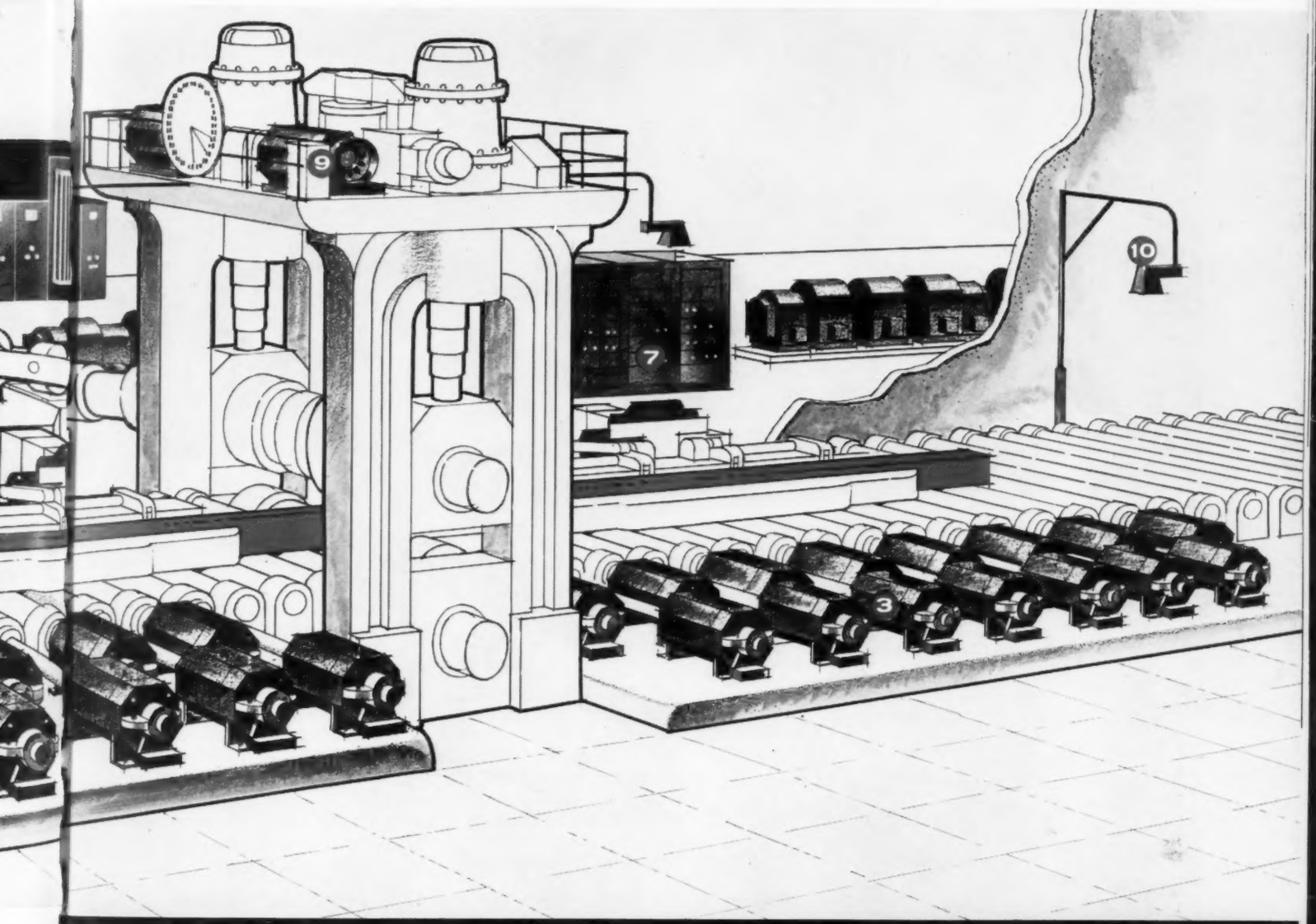
Implementation of General Electric's "Ring of the Future" will take you through the comparatively low-cost steps of modernization to practical automation of your reversing hot mill. Increased process and system efficiency will result in reduced operating costs. Greater speed and more precise control will minimize your non-productive rolling time, increase yield. For full information on Automation through Modernization, write today for General Electric's "Ring of the Future"* kit.



THE "RING OF THE FUTURE" KIT IS GENERAL ELECTRIC'S GUIDE TO AUTOMATION THROUGH MODERNIZATION.

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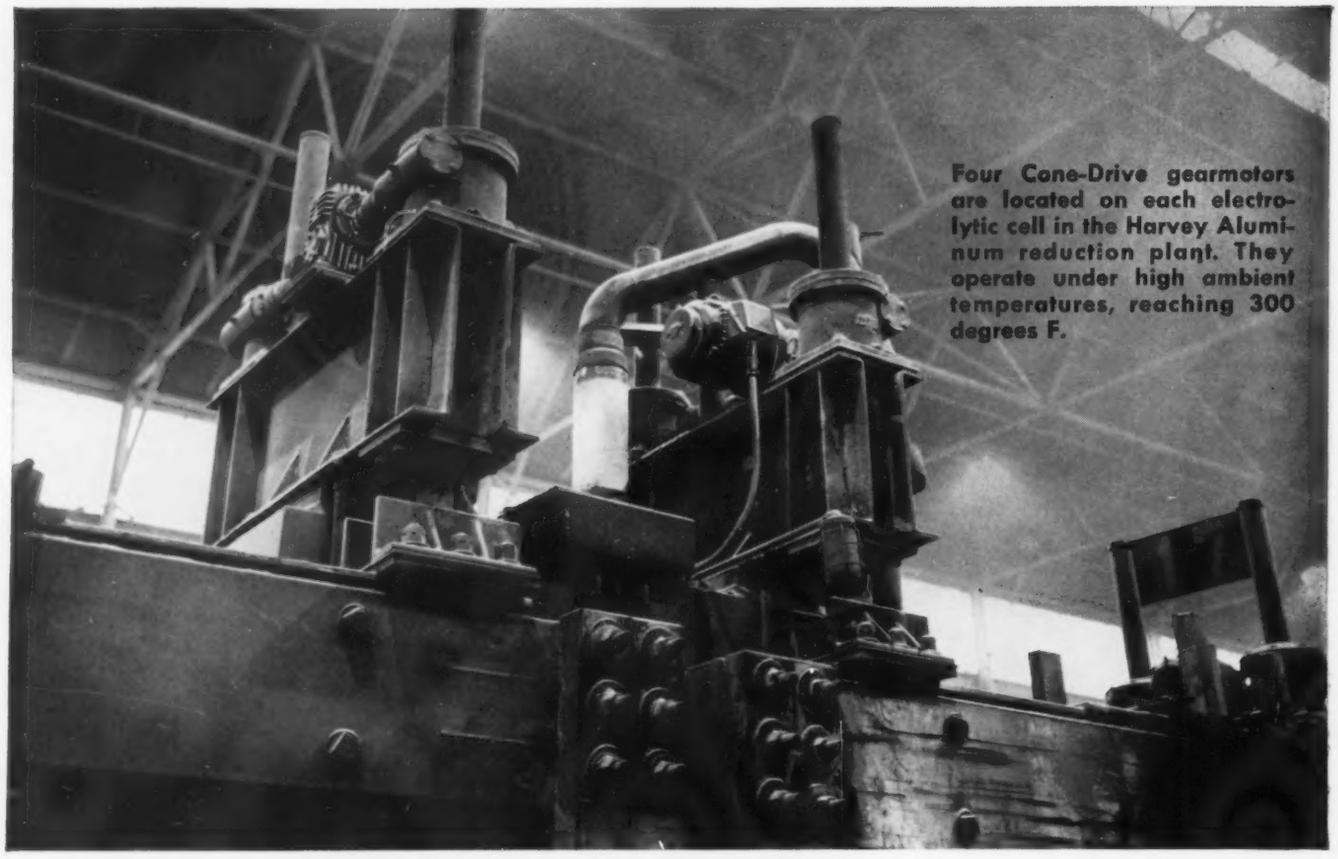
Automation Through Modernization

GENERAL ELECTRIC



Four Cone-Drive gearmotors are located on each electrolytic cell in the Harvey Aluminum reduction plant. They operate under high ambient temperatures, reaching 300 degrees F.

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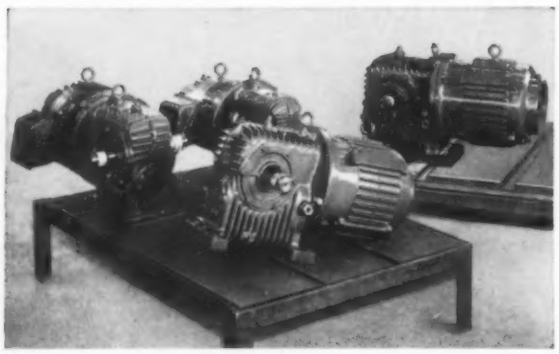
100,000,000-lb yearly capacity using 1,000 Cone-Drive gearmotors



Four double-enveloping worm gearmotors used by Harvey Aluminum are shown here after test run in Cone-Drive plant. They were palletized in groups of four for shipment to Oregon smelter.

From its modern reduction plant at The Dalles, Oregon, Harvey ships primary aluminum in pig, ingot and billet forms all over America. The smelter includes the latest and most efficient equipment and operating techniques. Reflecting this modern equipment are 1,000 Cone-Drive double-enveloping worm gearmotors, used to control the height of anodes and casings in relation to the molten aluminum bath in each of the electric furnaces. Annual capacity is more than 100-million pounds.

The gearmotors are operated under high ambient temperatures that reach 300° F. This was an important consideration in Harvey's selection of Cone-Drive gearmotors. In addition, the ability to withstand the full force of stalled driving motors and constant reversing operations figured in Cone-Drive gearing's selection.

Cone-Drive double-enveloping worm gearmotors are available in a wide variety of styles and sizes. Models include standard shaft or hollow shaft with worm over or under or gearshaft vertical. Capacities range from ¼ to 40 HP and reductions from 3.3:1 to 240:1. Ask for Catalog No. 58 for complete specifications.

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DOUBLE-ENVELOPING WORM GEARSETS

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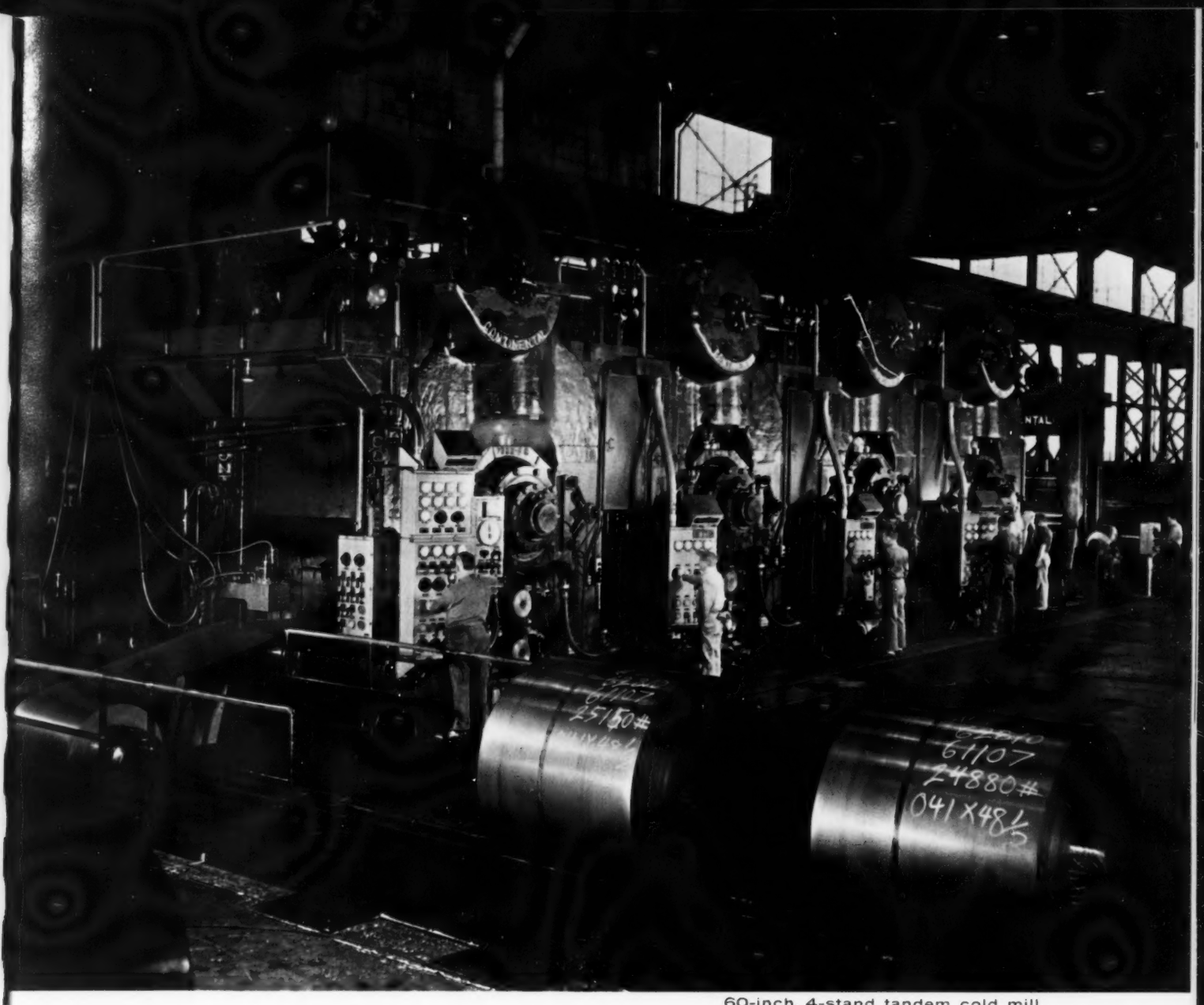
DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS



60-inch, 4-stand tandem cold mill

BLAW-KNOX COLD STRIP MILLS

Blaw-Knox designs and builds all types of cold reduction and temper mills for ferrous and non-ferrous work. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

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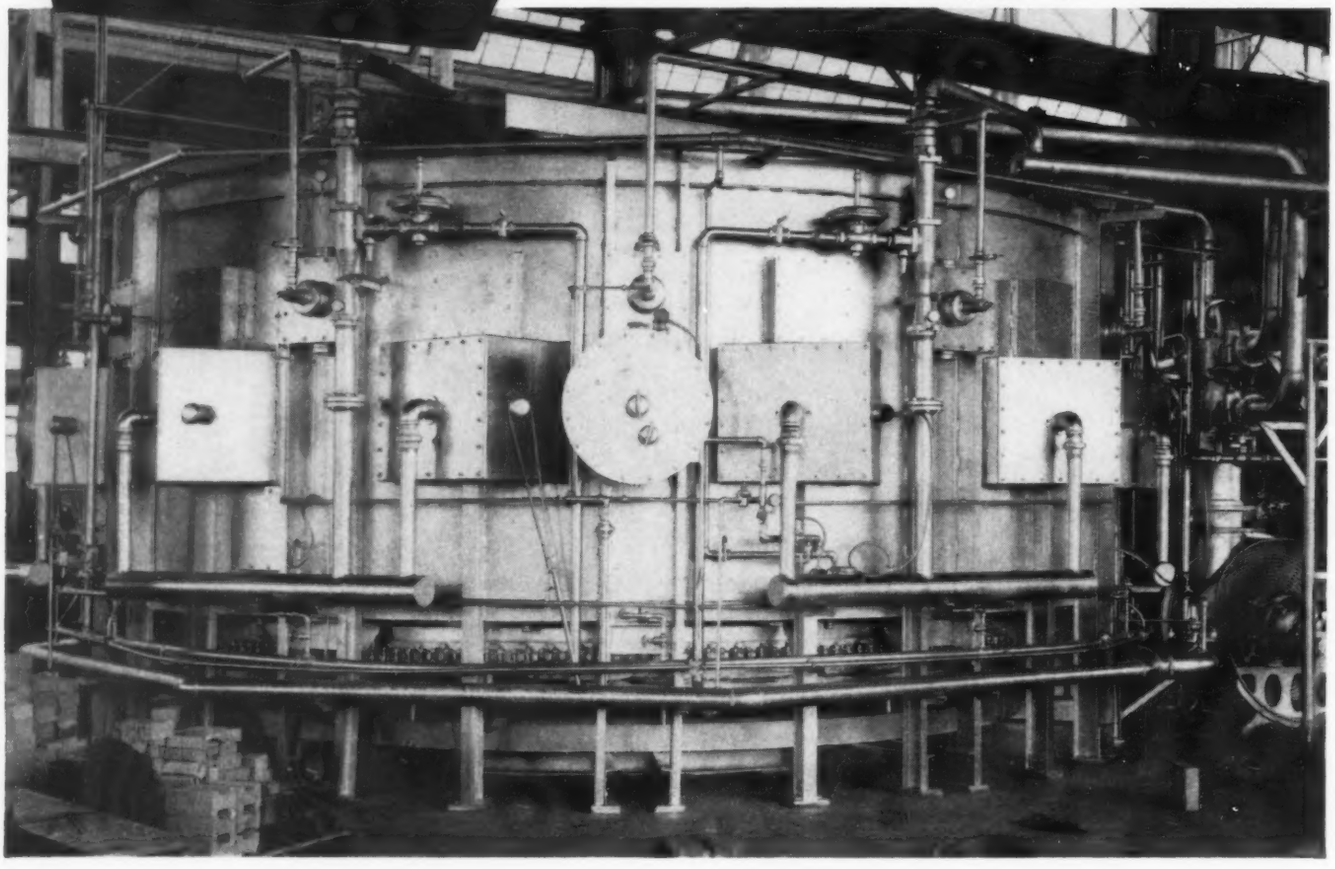
TAYCOR provides excellent hearth life *in this Lithium Company Furnace*



TAYCOR® (Corundum-base) Refractories have given exceptional service in this Lithium Recuperative Atmosphere Rotary Furnace*. Used for scale-free heating of 28-lb. billets to 2275-2300° F., the furnace is operated 5 days a week at a very high rate of production.

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TAYCOR is an ideal refractory for forge, welding, heating and heat-treating furnaces where abrasion and mill scale attack at high temperature cause early refractory failure. Put TAYCOR to a test in your furnaces. May we supply you with further information?

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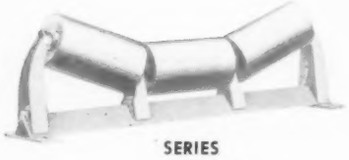

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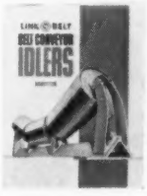

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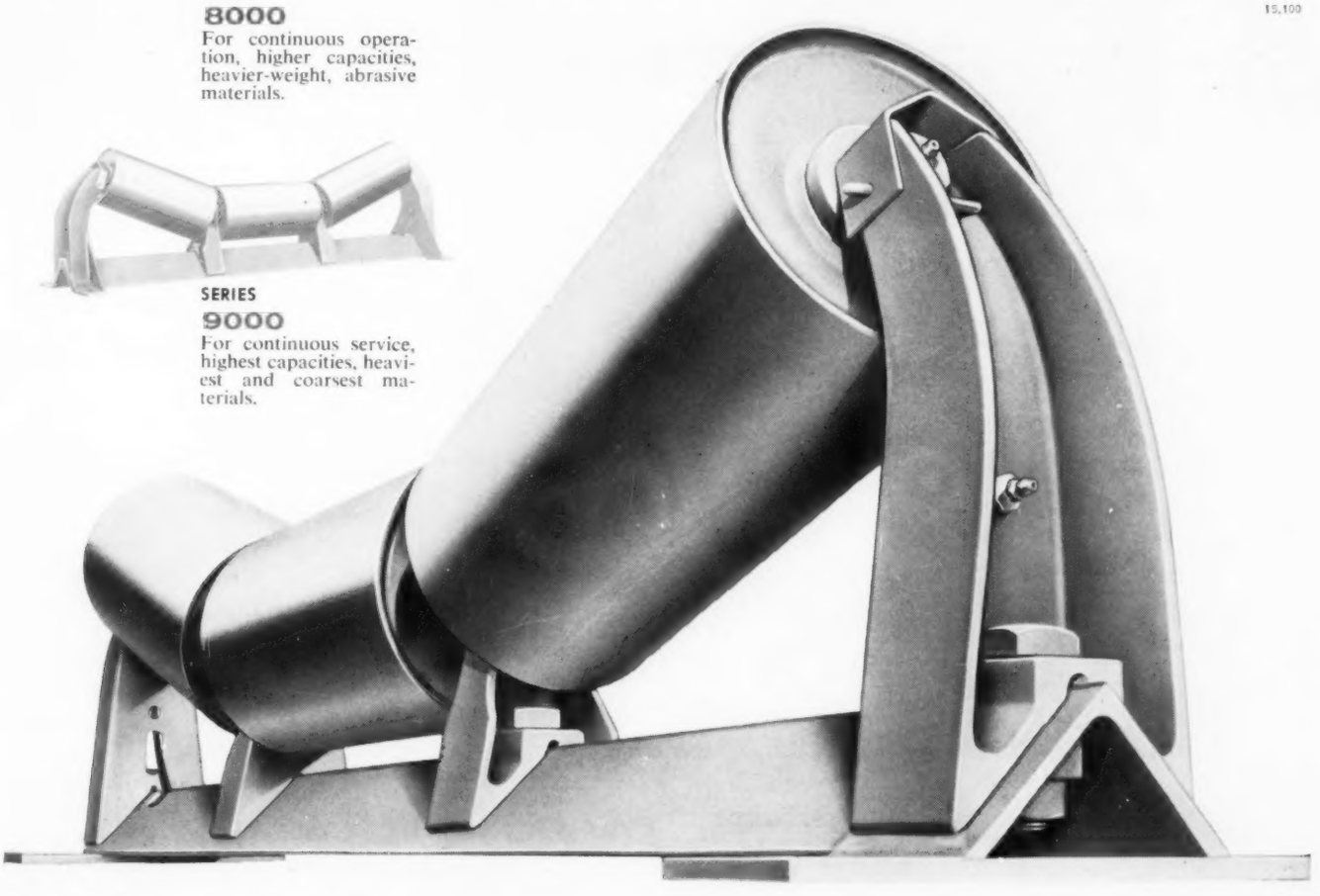

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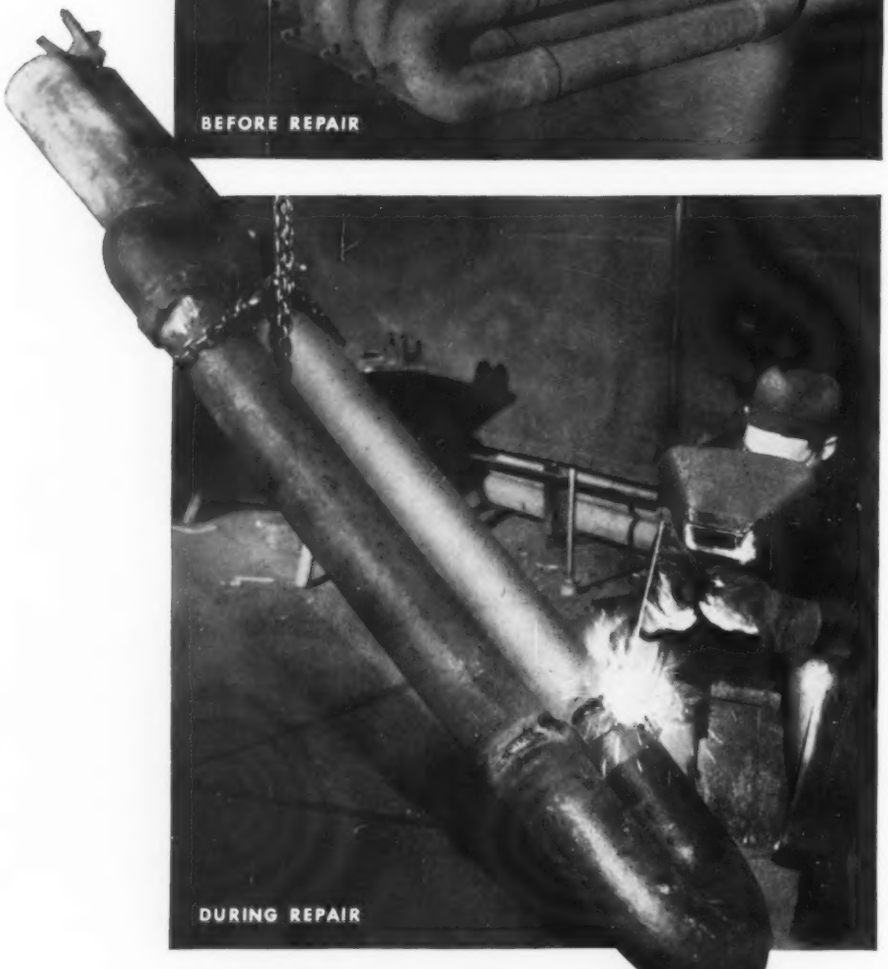

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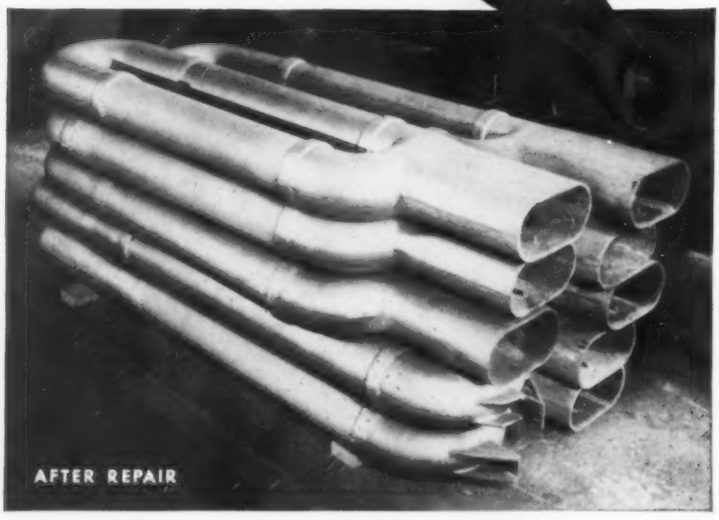

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period December 30, 1958 through January 20, 1959.

NOZZLE FOR TEEMING VESSEL

△ U. S. 2,866,241, issued Dec. 30, 1958 to E. A. Nirmaier and James B. Wagstaff, assigned to United States Steel Corp., describes a teeming nozzle for streamlining the flow of molten metal from a ladle into an ingot mold, in order to prevent cavitation and splashing.

As shown in Figure 1, a streamline flow through the orifice 10 is obtained under all conditions of pressure heads and velocities by venting the area 12 to the atmosphere. This is accomplished by drilling the nozzle 3 to provide a radially extending opening 14 which opens through the wall of the bore 8 into the orifice 10. A vertically extending opening 15 is bored in the nozzle 3 and has its upper end connected with the opening 14 and its lower end open to the atmosphere. With the area 12 vented in this manner by the openings 14 and 15, a streamline flow of liquid through the orifice 10 is had under all pressure heads and velocities which would otherwise be effective to cause a turbulent flow. In addition to eliminating turbulence, the venting action enables the use of nozzles 3 having a shorter length.

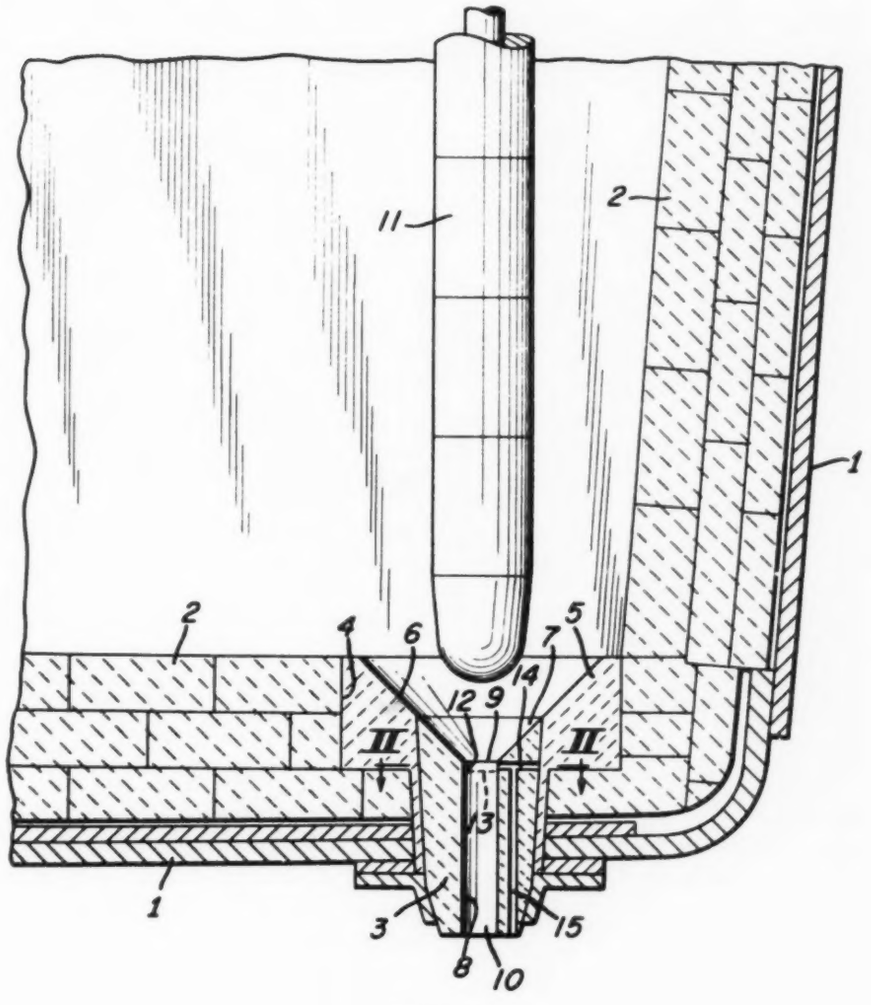


Figure 1

DESCALING APPARATUS FOR FORGING INGOTS

△ U. S. 2,867,893, issued Jan. 13, 1959 to Arne O. Andreson and Forrest A. Reinhart, describe apparatus for descaling hot metal preparatory to forging, rolling, and other die-forming operations. The apparatus may be made portable.

As shown in Figure 2, the descaling apparatus is self-contained and employs a combination of a water ram and an air accumulator to supply a sustained stream of water without appreciable pressure drop. The water ram 64 is operated by piston 62, actuated by air from the air accumulator tank 32. The ram cylinder 68 is recharged by an air-operated water pump 86, taking water from tank 200. The descaling spray ring 22 is enclosed in a cabinet so as to collect unvaporized water,

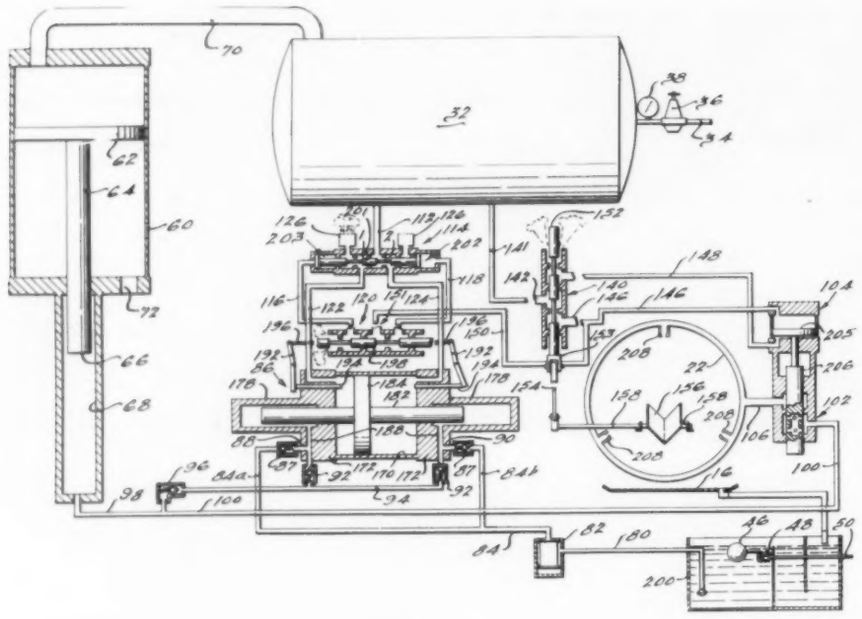


Figure 2

which flows back to the water tank 200. No sewer connections are required.

The apparatus is actuated by placing a billet on trigger 156.

HOT TOP FOR INGOT MOLD

△ U. S. 2,867,871, issued Jan. 13, 1959 to Harry D. Shepard, Jr., assigned to Foundry Services, Inc., describes a permanent hot-top for ingot molds, which is lined with an exothermically reacting material capable of producing and retaining sufficient heat to assure high yields of sound castings.

Shown in Figures 3, 4, 5 is a cast iron ingot mold 10, of the big end-up type, having a mold cavity 11 opening into an upper surface 12. A hot-top is placed on the top of the mold and consists of a permanent casting 19 formed with a feeder head cavity 20 extending through it and lined with a liner 21 made up of sand containing an exothermically reacting material.

An ingot is cast by placing a permanent hot-top casting fitted with a lining of exothermically reacting material on a mold and teeming molten steel into the mold through the hot-top. Pouring is continued until the mold and the hot-top is full (Figure 4). As the molten steel rises into the hot-top and into contact with the heat producing lining, the heat of the metal initiates the reaction of the exothermically reacting materials making up the liner. A substantial amount of heat is produced by this reaction and this heat keeps the metal in the hot-top in the molten state. A reservoir or feeder head 31 of molten metal is thus kept available for feeding the ingot as it solidifies and shrinks.

Provision is made for preventing runout of molten metal in the crack 32 between the mold 10 and the hot-top which results in the formation of hanger cracks in the solidified ingot. This is accomplished by projecting the bottom surface 33 of the hot-top casting 19 inwardly from the mold walls 15 to overhang the mold cavity 11 opening into the top of the ingot mold 10. The molten steel, when poured into the mold, contacts this overhanging hot-top surface 33 and is locally chilled to form a protective skin 35 which prevents runout in the crack 32 between the hot-top casting 19 and mold 10.

As the molten ingot metal solidifies, the ingot 38 shrinks and pulls away from the top of the mold as shown in Figure 5. The peripheral portions of the ingot solidify first and, when molten metal comes in contact with these relatively cooler solid portions, laminary layers of metal are formed which cause difficulties when rolling and working the ingot. Therefore, provision is made for preventing the flow of molten metal 31 from the hot-top over the solidified top portion of the ingot 38. To this end the heat producing liner 21 is spaced from the permanent hop-top casting to provide an annular space 39 between them. When molten steel is teemed into the ingot mold, it rises into this annular space 39 between the liner 21 and the casting 19 and is chilled by contact with the metal casting to form an annular collar or dam 40 on the upper end of the ingot. As the ingot 38 solidifies and shrinks and the top of the ingot falls below the upper surface of the mold and away from the hop-top, the dam 40 serves to confine the molten metal 31 from the hot-top to the central area of the mold.

FURNACES FOR HEATING STEEL BILLETS

△ U. S. 2,867,431, issued Jan. 6, 1959 to Frederic O. Hess, assigned to Selas Corp. of America, describes a furnace and method of heating steel billets to forging temperature.

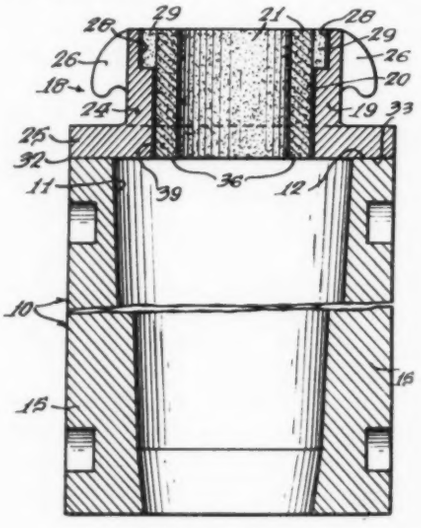


Figure 3

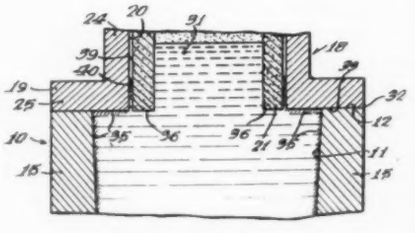
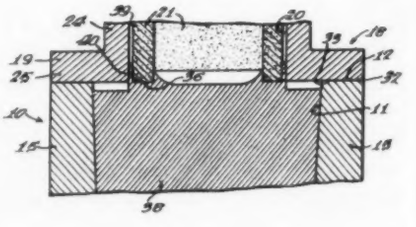
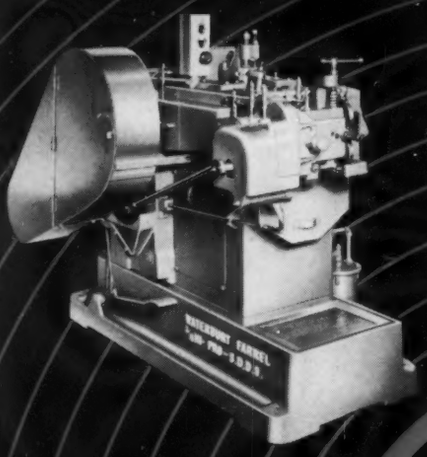


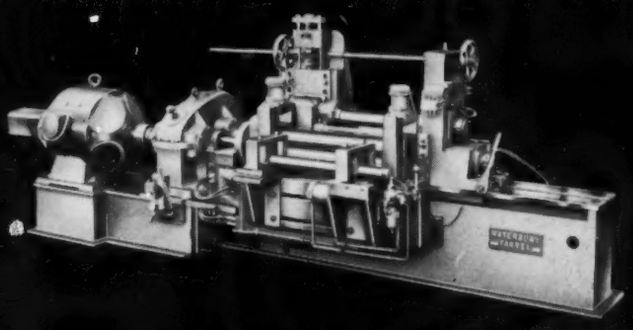
Figure 4

Figure 5



COLD HEADING MACHINERY





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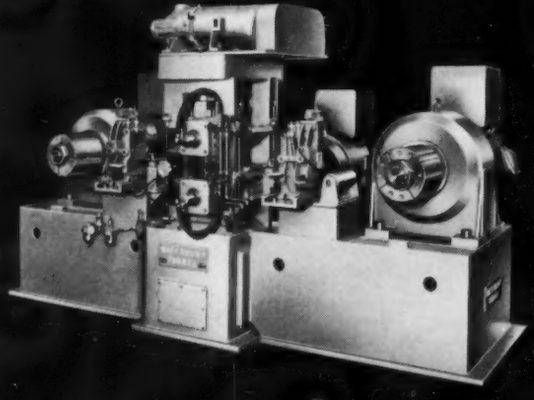

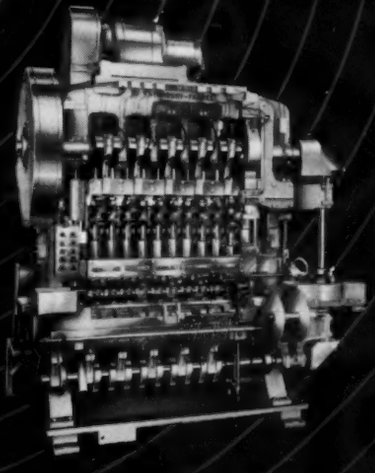

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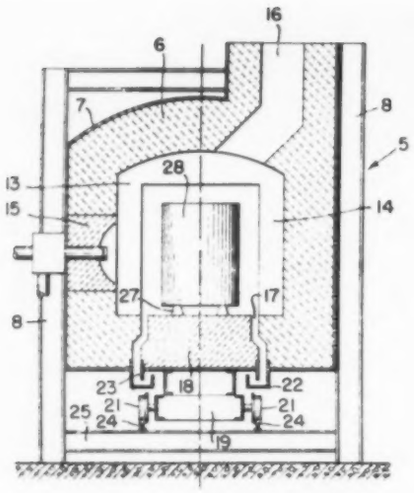


Figure 6

In the present invention, the billets are heated rapidly from the time they are placed in the furnace until the billet interior reaches substantially its transformation temperature. At that point, the exterior of the billet is kept at the temperature that it has attained, while the interior is heated by conduction until it has passed the transformation point. Thereafter, the billet is again heated rapidly until it has reached the temperature required for forging or other hot working operation. During the final portion of the heating, the interior heats more rapidly relative to the speed of heating of the exterior than was the case at the first portion of the heating, so that both the interior and exterior of the billet are at substantially the same temperature by the time the final temperature is reached.

As shown in Figure 6, the furnace is an elongated tunnel-like structure through which the billets are moved. Adjacent to the entrance, there is provided a heating zone, and adjacent to the exit of the furnace, there is provided another heating zone. Between these two, there is provided a zone whose temperature is maintained by hot products of combustion drawn toward the center from the end zones.

SELF-CENTERING ROLL

△ U. S. 2,869,866, issued Jan. 20, 1959 to Edwin T. Lorig, assigned to United States Steel Corp. describes a self-centering roll having a smooth outer surface made of flexible material.

In Figures 7 and 8, each of the rolls 2 has a metallic core 4 supported by shaft portions 6. The shaft portions 6 are supported in bearings 8. When used in a pinch roll arrangement as shown, one of the rolls is provided with a shaft extension 10 which is connected to be driven from a motor 12. A covering 14 of rubber is secured to the core 4. The generally cylindrical outer surface of the covering 14 is provided with a radial slot 16 in a transverse central plane and slots 18 and 20 on each side thereof extending inwardly toward the roll axis away from the transverse central slot 16. Surrounding the covering 14 is a thin flexible cylindrical sleeve 22. The sleeve 22 is preferably about one-quarter inch thick and of softer material than the material of covering 14. The sleeve 22 may be made of any low modulus material such as rubber leather, cloth, fabric, or the like which can move readily under load A confining web 24 having a diameter slightly less than the diameter of sleeve 22 is attached to the core 4 at each end therof.

As the strip S passes between a pair of rolls or over a single roll 2, forces are exerted tending to keep the strip centered and alined. Wear of the roll all takes place on the sleeve 22 and when the sleeve 22 wears to such an extent that the roll will not operate satisfactorily it is only necessary to replace it by a new sleeve 22. Thus it is only necessary to keep relatively cheap sleeves rather than expensive rolls in stock.

CONVERSION OF HEMATITE TO MAGNETITE

△ U. S. 2,870,003, issued Jan. 20, 1959 to Patrick E. Cavanaugh, assigned to Ontario Research foundation, describes a process for converting hematite to magnetite.

As shown in Figure 9, finely crushed hematite ore is introduced in an air stream at 1 into a dust thickener, illustrated in the drawing as at 2. This is a cyclone dust collector, from which is withdrawn, at 3, a controllable amount of air, plus the finely crushed ore. The major portion of the air introduced at 1 (90 per cent or more) will be discharged at the top of the thickener 2 by means of a duct at 4 and will carry with it a portion of the very fine ore dust. A gas or oil burner is provided at 5 which is directed downwardly into the interior of a furnace 6. Fine dust will be fed through the opening surrounding the burner so that it is

Figure 7

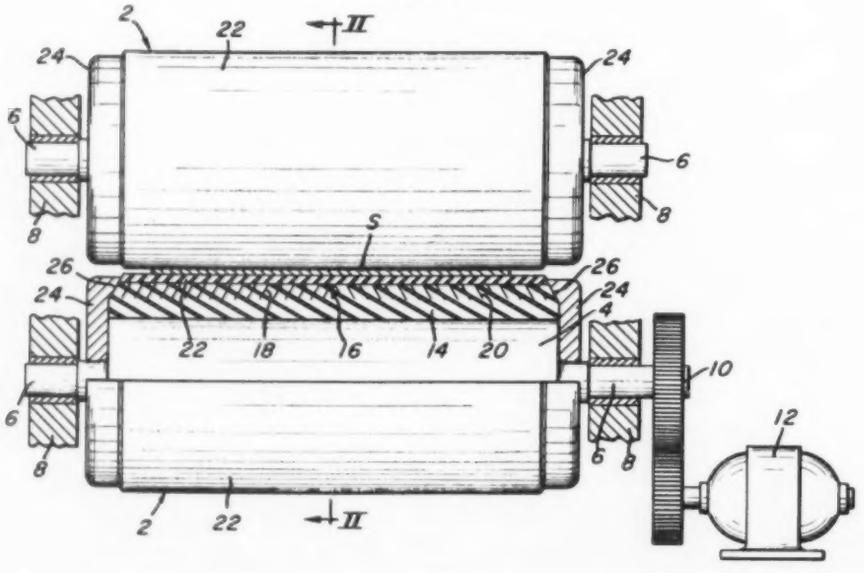
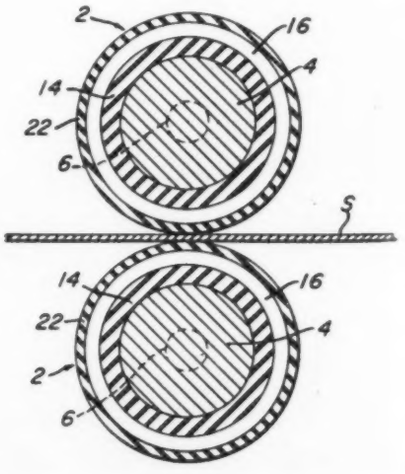


Figure 8



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Charging-box cars have to take a lot of punishment. And, in the 36 years we have been making charging-box cars for our own use, United States Steel has developed several features in structural design that assure longer life, less maintenance, and dependable service.

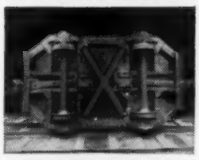
As illustrated in the typical four-box car shown here, the advantages of these design features—plus the rugged durability of all-welded *rolled* steel construction—make any size USS Charging-Box Car a profitable investment.

Our representatives will be pleased to call at your convenience to discuss your requirements for this or any other type of industrial car. Meanwhile, write for our free illustrated booklet—*USS Custom Designed Cars.* United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS is a registered trademark

Box girder construction: Two channel sections, welded toe-to-toe, provide a frame far stronger than the ordinary angle or channel frame. This box frame is used under both the sides and ends of the car.

Double center sills: *Two* channels, back to back, run the entire length of the car. All cross members are welded to these sills, providing superior longitudinal rigidity.



X-frame bracing: These cross braces tie the box girder frame and the center sills together for additional strength and rigidity.

Spring pockets: Over each wheel, pockets are built into the bottom of the frame and "boxed in" on all sides. Coil springs are set into these pockets. This construction permits vertical, but no lateral, movement of the springs.

Long-shanked couplers: Pivot points of couplers are *behind* each axle. This permits turning the car on a short radius curve with less wheel flange pressure than with a short-shanked coupler.

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United States Steel Export Company

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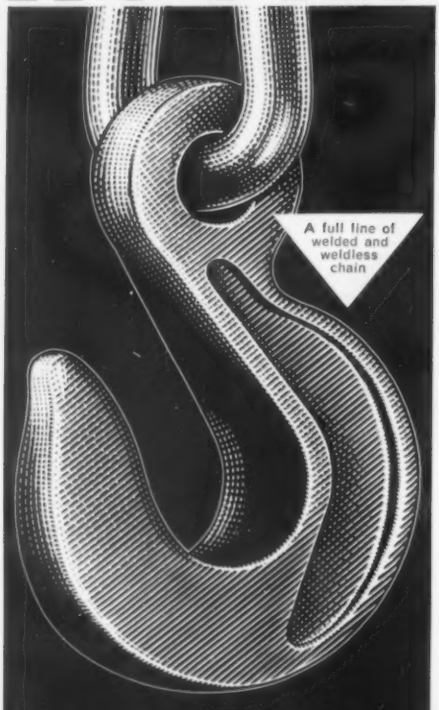

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discharged into the flame below the burner. The burner is regulated so that the air supplied is insufficient to provide full combustion. A reducing flame, directed downwardly, is produced at 7, being so adjusted as to be strongly reducing and to produce an ore temperature of from 1800 to 2000 F.

The upper portion 8 of the furnace 6 is lined with refractory brick while a cooling zone 9 is provided towards the lower extremity. The combustion gases with the reduced dust entrained in it are discharged through outlet 12 at the bottom of the furnace 6, into a larger chamber 15. This will cause a decrease in the velocity of the gases whereupon the solid particles will drop and be discharged via outlet 10 for subsequent magnetic separation, the warm gases rising and being withdrawn through duct 13. The gases may be subjected to further dust collection if desired.

The upper portion 8 of the furnace 6 will be so designed that the ore particles reach a temperature above 1800 F. The bottom portion 9, which may be provided with a water cooling jacket 14, is designed to bring the temperature of the ore particles down below about 900 F.

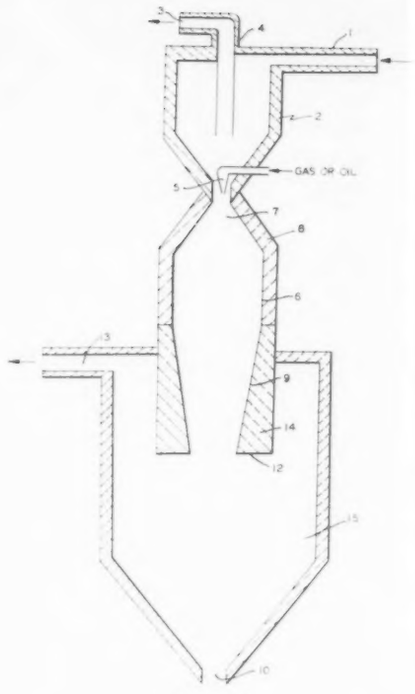

Figure 9

It has been found that in a strongly reducing gas at a temperature of 1800 to 2000 F, at least the hematite on the surface of ore particles less than 150 mesh is reduced to magnetite in about one second, according to the reaction:

$$3Fe_2O_3 + CO \rightarrow 3Fe_3O_4 + CO_2$$

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,866,247	12/30/58	Safety lock for crane hook	United States Steel Corp.
2,866,503	12/30/58	Shear apparatus	Republic Steel Corp.
2,866,628	12/30/58	Open hearth furnace	Loftus Engineering Corp.
2,866,699	12/30/58	Preparation of ore fines for sintering	Kloeckner-Huttenwerk Haspe A. G.
2,866,729	12/30/58	Quenching oil compositions	Shell Development Co.
2,867,531	1/6/59	Corrosion-resistant low alloy steel	General Motors Corp.
2,867,532	1/6/59	Wear resistant alloy steel	Crucible Steel Co. of America
2,867,533	1/6/59	Method for overcoming embrittlement of steel alloys	Electric Steel Foundry Co.
2,867,555	1/6/59	Manufacture of nodular cast iron	Thomas W. Curry
2,867,557	1/6/59	Production of silicon steel strip	Allegheny Ludlum Steel Corp.
2,867,558-9	1/6/59	Production of grain-oriented silicon steel	General Electric Co.
2,868,059	1/13/59	Steel mill optical width gage	General Electric Co.
2,868,348	1/13/59	Rolling mill kickout apparatus	Mannesmann-Meer Engineering & Construction Co.
2,868,370	1/13/59	Device for packaging coiled material	United States Steel Corp.
2,868,637	1/13/59	Valve material	Rich Manufacturing Corp.
2,868,680	1/13/59	Method of pickling and coating stainless steel in the same bath	Devex Corp.
2,868,860	1/13/59	Electric furnace	Elektrokemisk A-S
2,869,241	1/20/59	Apparatus for measuring the length of strip	United States Steel Corp.
2,869,432	1/20/59	Machine for planing a hot ingot	Herbert Sedlaczek and Oskar Waldrich
2,869,488	1/20/59	Dual Arch	United States Steel Corp.
2,869,845	1/20/59	Crucible furnace	United States Steel Corp.
2,869,846	1/20/59	Strip heating furnace	Selas Corp. of America
2,870,004	1/20/59	Production of nodular cast iron	Air Reduction Co.
2,870,005	1/20/59	Heating the head of an ingot of molten ferrous metal	South African Iron & Steel Industrial Corp. Ltd.

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Stamco Slitting and Coiling Lines will step up your production because they are designed to meet your particular specifications. Years of experience have led to the development of equipment that will meet every slitting and coiling requirement. Stamco slitting and coiling lines are now efficiently handling coils from 500 to 60,000 pounds and are designed to give dependable, maintenance-free service.

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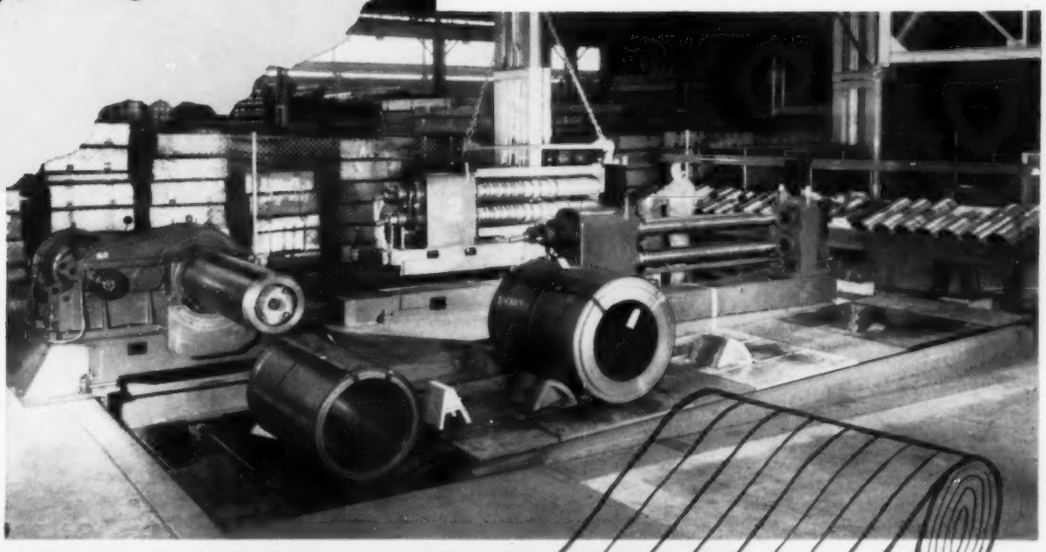
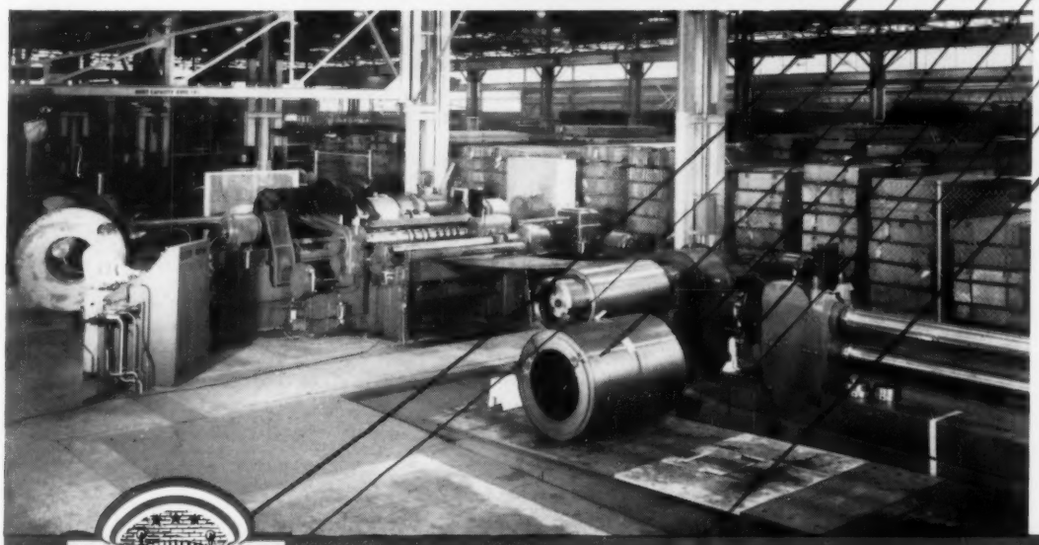


View shows coil and traverse, coil pay off reel, coil loading ramp and detachable slitter head.



Overall view of coiling line from entrance end.

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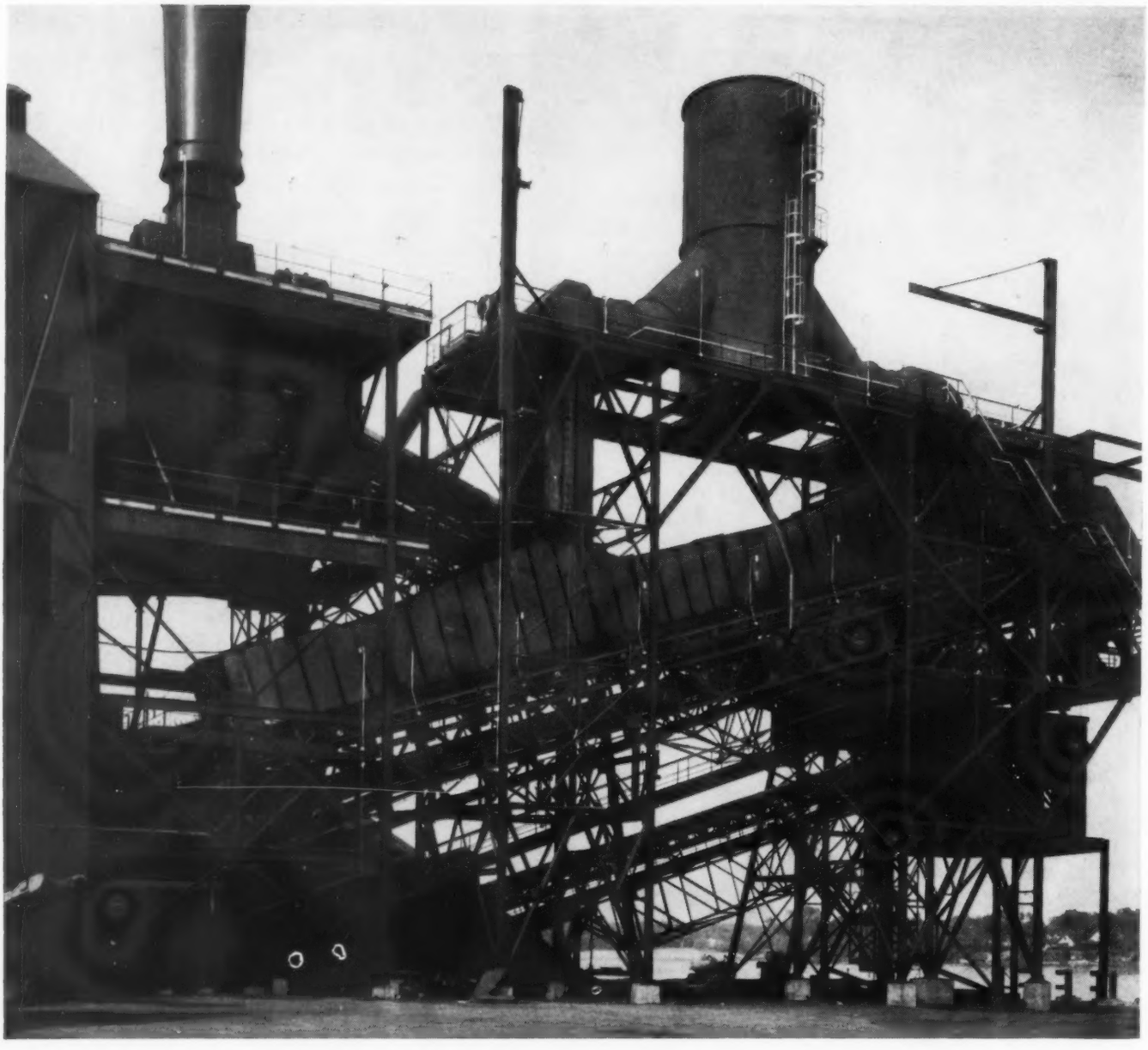

sinter air-cooled and elevated at same time . . .

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Utilizing the air-cooling principle which delivers more *usable* tonnage, the Dravo-Lurgi straight line cooler raises sinter at the discharge end for storage in bins or for conveying. Output is increased by reduction of shattering and dust.

Where space permits its installation, the straight line design provides an extremely efficient method for both cooling and handling sinter. Here are some of the features which lead to maximum utilization of any sinter machine:

- No water quenching to cause shattering, cracking or brittleness.
- No need for plows or scrapers at the discharge end.
- Sinter is undisturbed during cooling—breakup is minimized.
- Sinter is elevated while cooling, facilitating loading.

A Dravo engineer will be glad to explain how Dravo-Lurgi coolers (either straight line or circular) can increase *usable* tonnage in your sintering operation. Write or phone DRAVO CORPORATION, PITTSBURGH 22, PENNSYLVANIA.

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IF you're interested in putting the brakes on *your* rising costs--here's a very practical suggestion.

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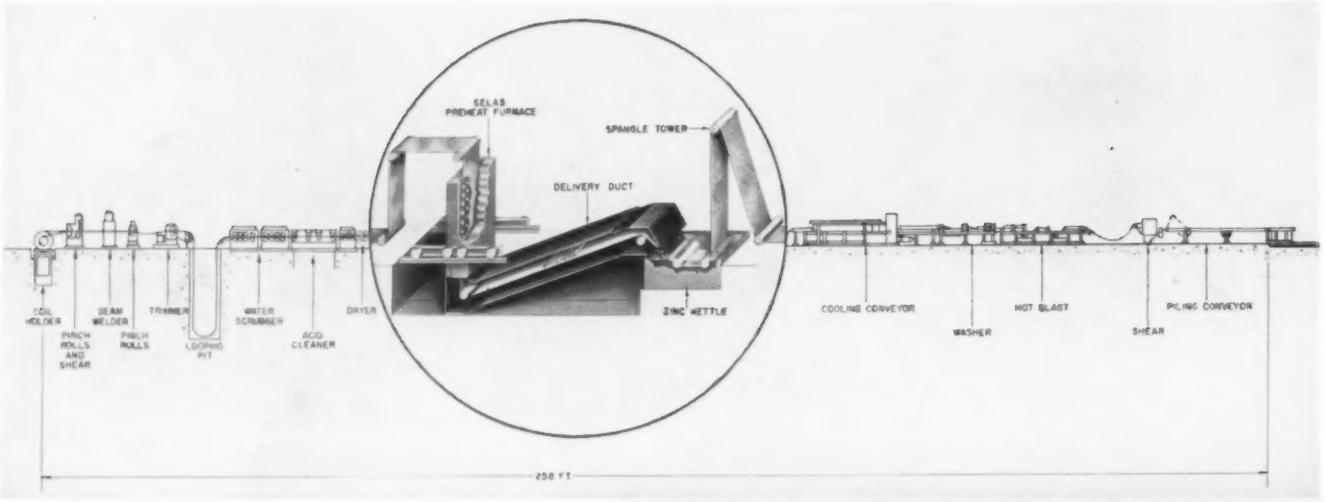


SELAS Gradiation®: Precise Heat Processing for the Steel Industry

Photo courtesy Weirton Steel Co.

STRIP is preheated to 950°F in this unique Selas approach to continuous galvanizing, which eliminates kettle firing during line operation. Gradiation unit, consisting of furnace and delivery duct, replaced fluxing and drying equipment; was fitted into space available between strip cleaning and spangle tower. Furnace accommodates strip from 18 to 30 gage, 24 to 48 in. wide, at speeds from 56 to 225 fpm. Monthly production increased 30% . . . 151,000 tons of strip galvanized before replacing kettle.

Throughout the steel industry — in mills and metalworking plants — Selas Gradiation heat processing is successfully used in many operations. The versatility and adaptability of the Gradiation principle are demonstrated by the diversity of applications shown in the installation photographs on these pages.

Gradiation is a concept and technique of heat processing which coordinates fast, controlled heating with the nature of the workpiece . . . considering its composition, size, shape, heat transfer characteristics and physical properties . . . to develop desired product quality, in minimum time, with maximum efficiency, and with the use of automatic and compact equipment.

Designed and custom-built to meet your specific heat processing needs . . . for hot working . . . galvanizing . . . tinning . . . heat treating heavy sections and special shapes . . . Gradiation equipment contributes production economy, high production rates, ease of handling.

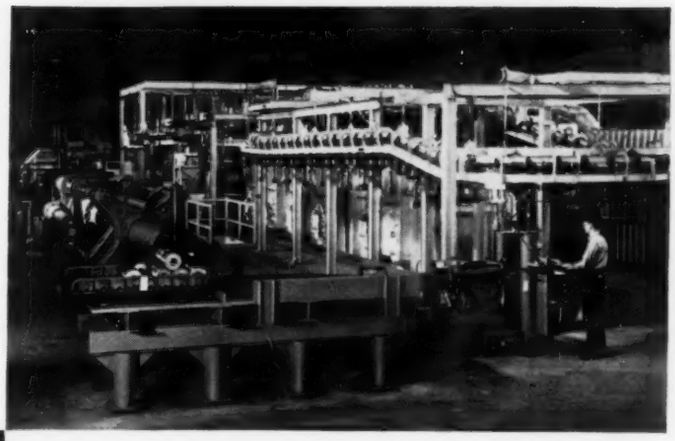
Selas Engineers will be pleased to discuss your heat processing needs with you and to show you how Gradiation can be adapted to your particular requirements.

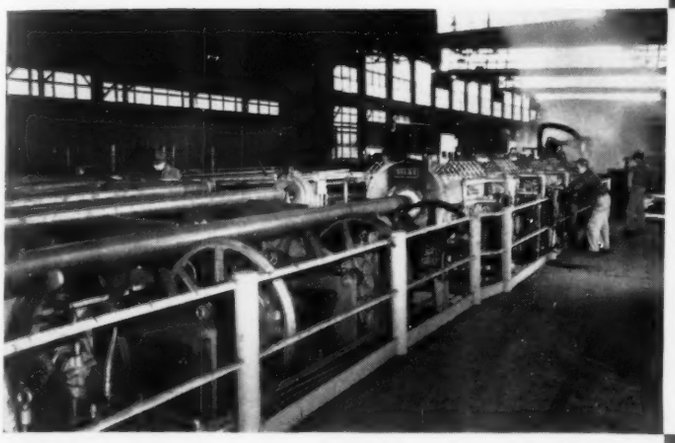
Send for our new 28-page Bulletin No. 46 "Selas Gradiation Heating in the Steel Mill" and article reprint "An Economic Appraisal of Continuous Heat Processing."

SUBSIDIARIES: Selas Constructors, Inc., Houston, Texas; Selas Corporation of America, European Div., S. A., Pregny, Geneva, Switzerland. **INTERNATIONAL REPRESENTATIVES AND LICENSEES:** BENELUX, FRANCE—Cie Gle de Construction de Fours, Paris; CAMBODIA, FORMOSA, KOREA, LAOS, VIETNAM—Cosa Export Co., Inc.; AUSTRIA, GERMANY—Indugas, Essen; JAPAN—International Machine Co., Ltd., Tokyo; ITALY—Italiana Gasogeni E. Forni S.r.l., Milano.

is your reward

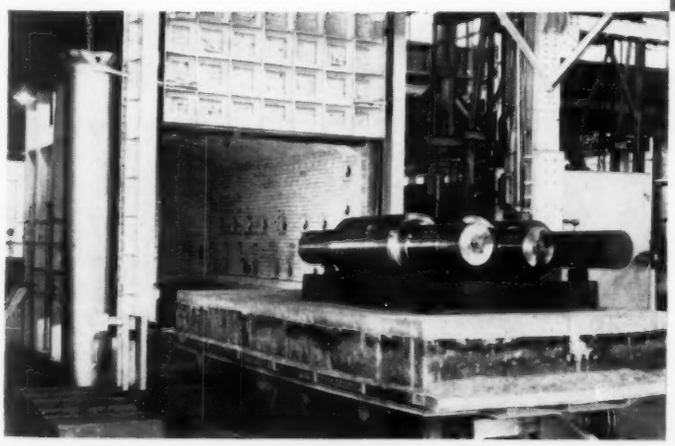
STAINLESS STEEL BILLETS, 5¾ to 8 in. in diam and from 9 to 28 in. in length, are heated for extruding into tubes, in this Selas direct-fired furnace. Billets are welded to studs for simplified handling on monorail conveyor system. Fully automatic control of heat input and temperature measurement assures preciseness and uniformity of temperature in billets, essential to achieving dimensional accuracy of extruded tubes.





SEAMLESS TUBING is hardened and tempered in this Selas barrel-furnace line to produce oil-well casing for the petroleum industry. The pipe is heated to 1600°F in five barrel furnaces, quenched by an annular water spray unit, then tempered in succeeding five barrel furnaces. Rotation of the pipe during its forward motion (during heating and cooling) assures uniformity of metallurgical properties and straightness. Pipe 5 in. to 9⅝ in. O.D. is handled in this completely automated line.

TUBE-ENDS are heated for upsetting (for subsequent threading) in this slot-type Selas furnace. As each tube-end is fast heated to 2300°F, the tubing automatically moves down the handling table to the upsetting machine. The direct-fired Duradiant® gas burners are patterned to assure temperature uniformity within a limited area of each tube-end.



CAST-STEEL ROLLS and other alloy steel castings are annealed in this Gradiation-fired car-bottom furnace, at Ohio Steel Foundry, Lima, Ohio. Preciseness of control and uniformity of heating enables prescribed time-temperature cycles — required in processing the sensitive cast-steel structures — to be followed.

Gradiation and Duradiant are registered trade names of Selas Corporation of America.

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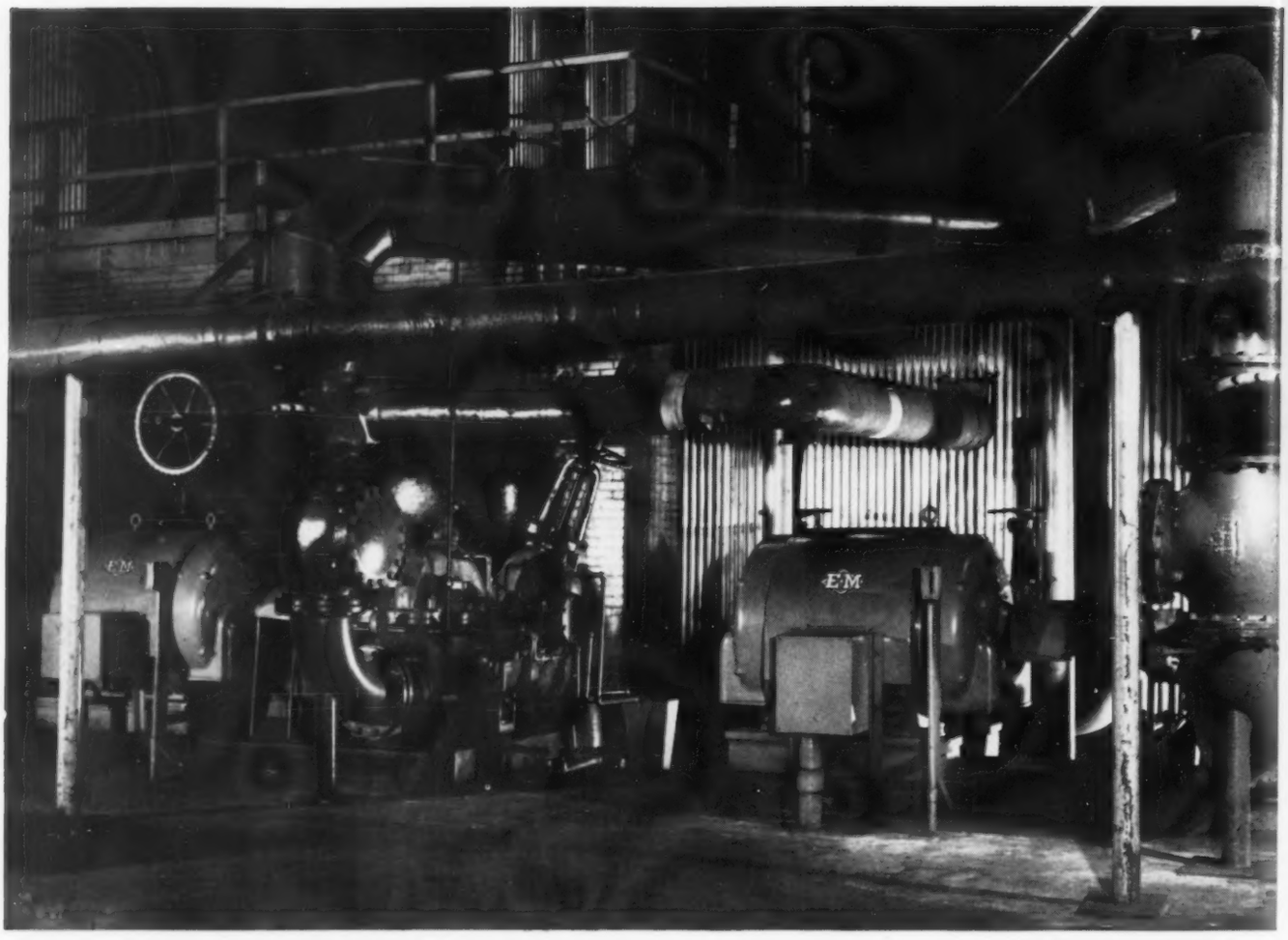

Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

For your next *special* motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Foto-Facts No. 16, showing other modern motor applications in a modern steel mill.

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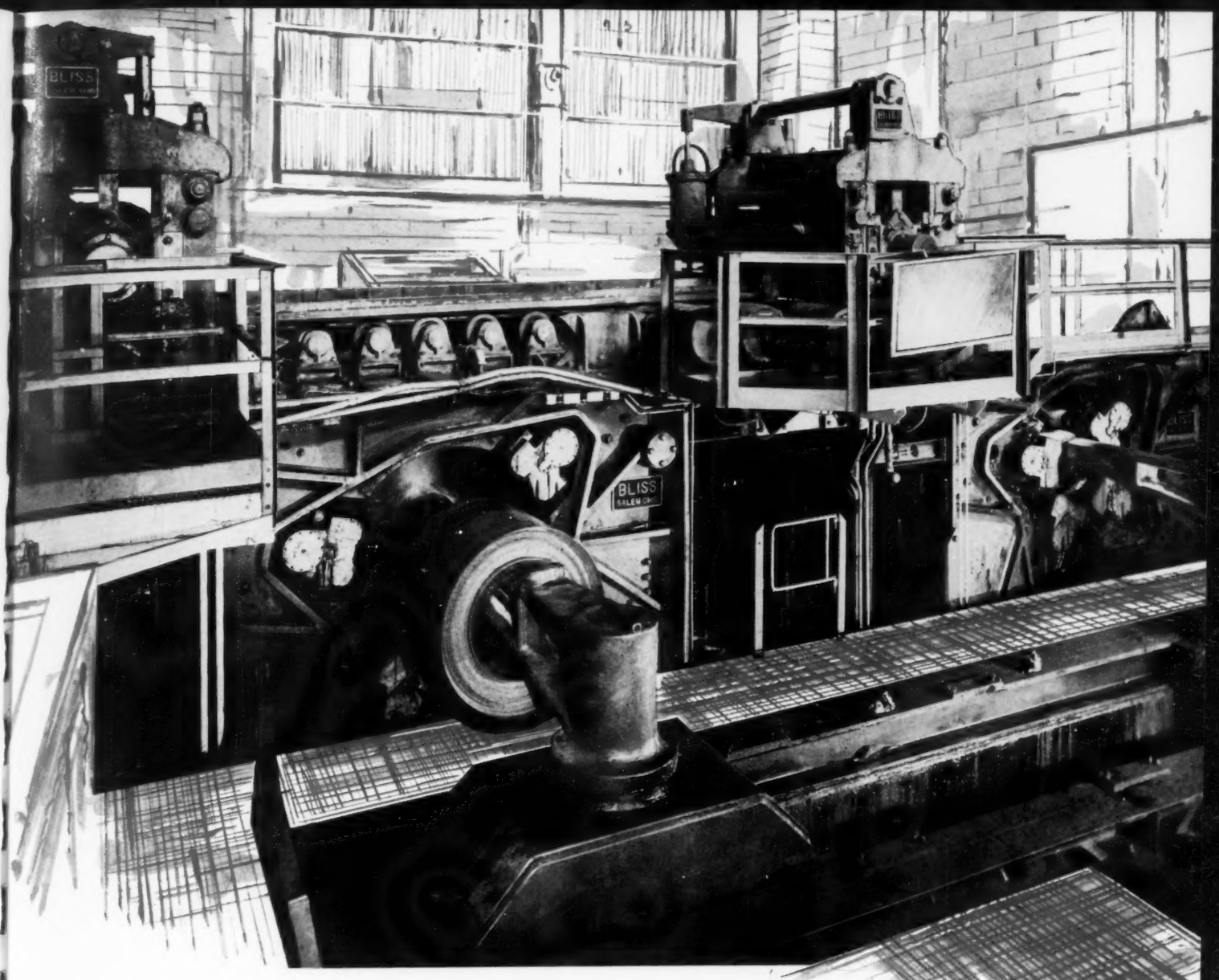


FROM MILD STEEL TO STAINLESS

It's all the same to these two Bliss coilers at Armco

These smooth-running Bliss downcoilers on the new 56" hot strip mill at Armco Steel Corporation's Butler, Pa. Works, coil everything from flexible mild steel to tough, springy stainless steel strip. Bliss coilers, with their expanding mandrels and positive wrapping action were used because of the variety of gages and alloys to be put through the new mill. In the Bliss design, the mandrel keeps the strip in tension during coiling; wraps a tight, smooth-edged coil without surface scratches or marks. Blocker rolls retract as soon as leading end has been snubbed on the mandrel, and don't move in again until the trailing end is coming through the pinch rolls.

Besides the two downcoilers, Bliss' Rolling Mill Division designed and built the 100-yard-long runout table as another contribution to the Butler Works' handsome new hot strip line. For other examples of Bliss engineering for the ferrous and nonferrous industries, why not write for a free copy of the new profusely illustrated 84-page Bliss Rolling Mill Brochure, Bulletin 40-B? It describes the operation of Bliss mills and auxiliary equipment.

BLISS
SINCE 1857

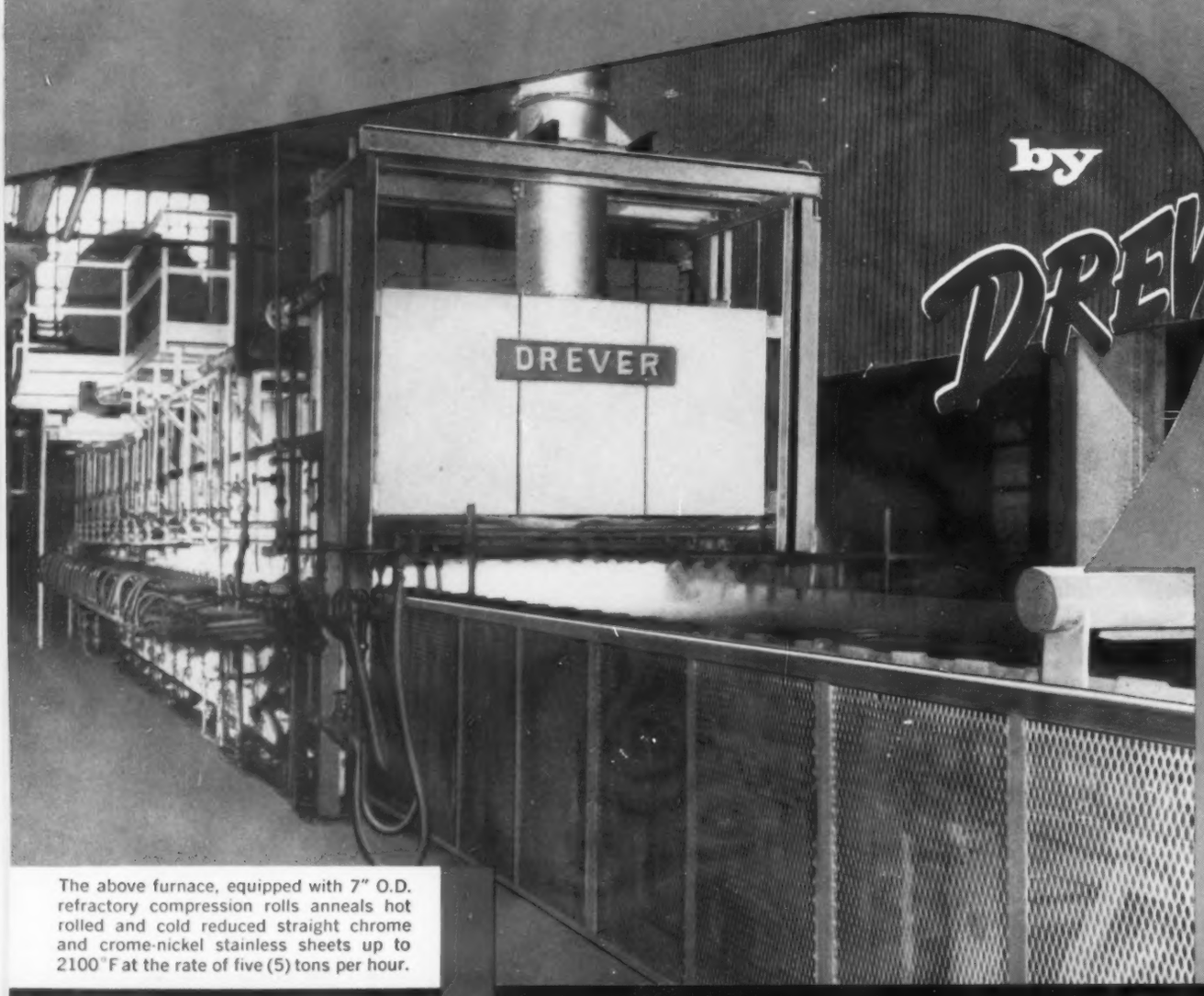
Bliss is more than a name... it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

ROLLER HEARTH
FURNACES

for Operation at 2300°F
Utilizing Drever Refractory Compression Rolls



by DREVER

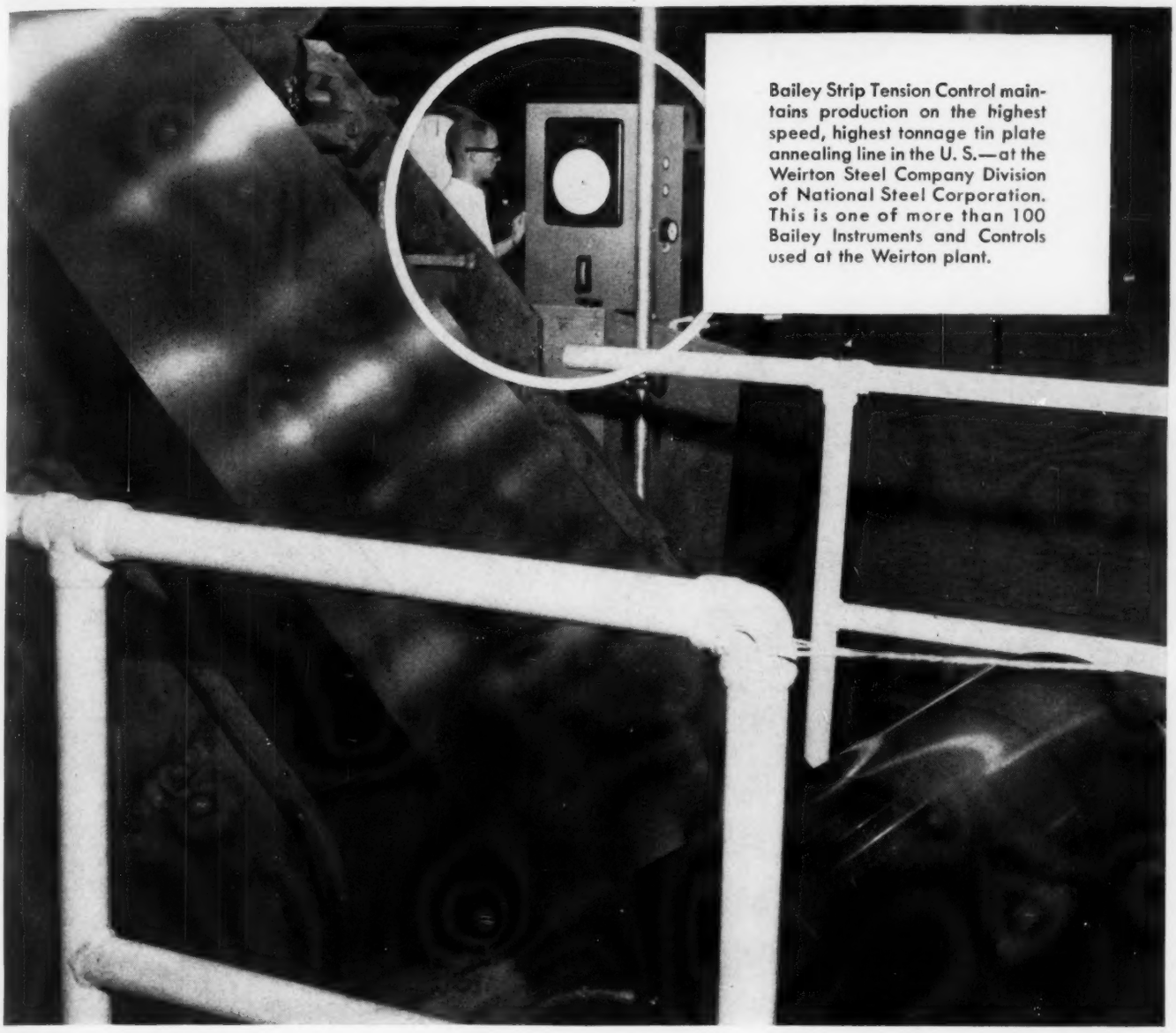
The above furnace, equipped with 7" O.D. refractory compression rolls anneals hot rolled and cold reduced straight chrome and crome-nickel stainless sheets up to 2100°F at the rate of five (5) tons per hour.

The success in utilizing the Drever Refractory Compression Roll in annealing stainless steels has been attributed to the roll strength and its resistance to pickup which completely eliminates the necessity of using rider sheets. The refractory rolls are prestressed and consist of silicon carbide sections retained by spring loaded alloy ends to allow for expansion and to provide axial forces to insure structural stability under rated load. Furnaces have been installed with roll sizes varying from 4½" O.D. x 20½" long to 14" O.D. x 14'-6" long.

In addition to annealing stainless steel sheets, plates, bars and tubing, materials have been successfully heat treated at 2300°F. Avail yourself of the experience of Drever Company engineers in solving your stainless steel annealing problems.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.



Bailey Strip Tension Control maintains production on the highest speed, highest tonnage tin plate annealing line in the U. S.—at the Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls used at the Weirton plant.

Strip keeps rolling when Bailey keeps an eye on it

Installing Bailey Strip Tension Control will cost you far less than a single strip breakage in a furnace due to poor tension control . . . and it's the surest way of ending tension problems.

Strip tension at speeds up to 2000 feet per minute is pre-set, controlled, and recorded by this unique system. Bailey S.T.C. eliminates undue instantaneous strains through natural 'cushioning' of pneumatic control. It helps maintain strip flatness during finishing operation by minimizing slack formations, and it simplifies strip tracking by holding tension within allowable limits.

If you roll strip, see your Bailey Engineer about Strip Tension Control, or write the Iron and Steel Division for more information.

S114-1

IRON AND STEEL DIVISION

BAILEY METER COMPANY

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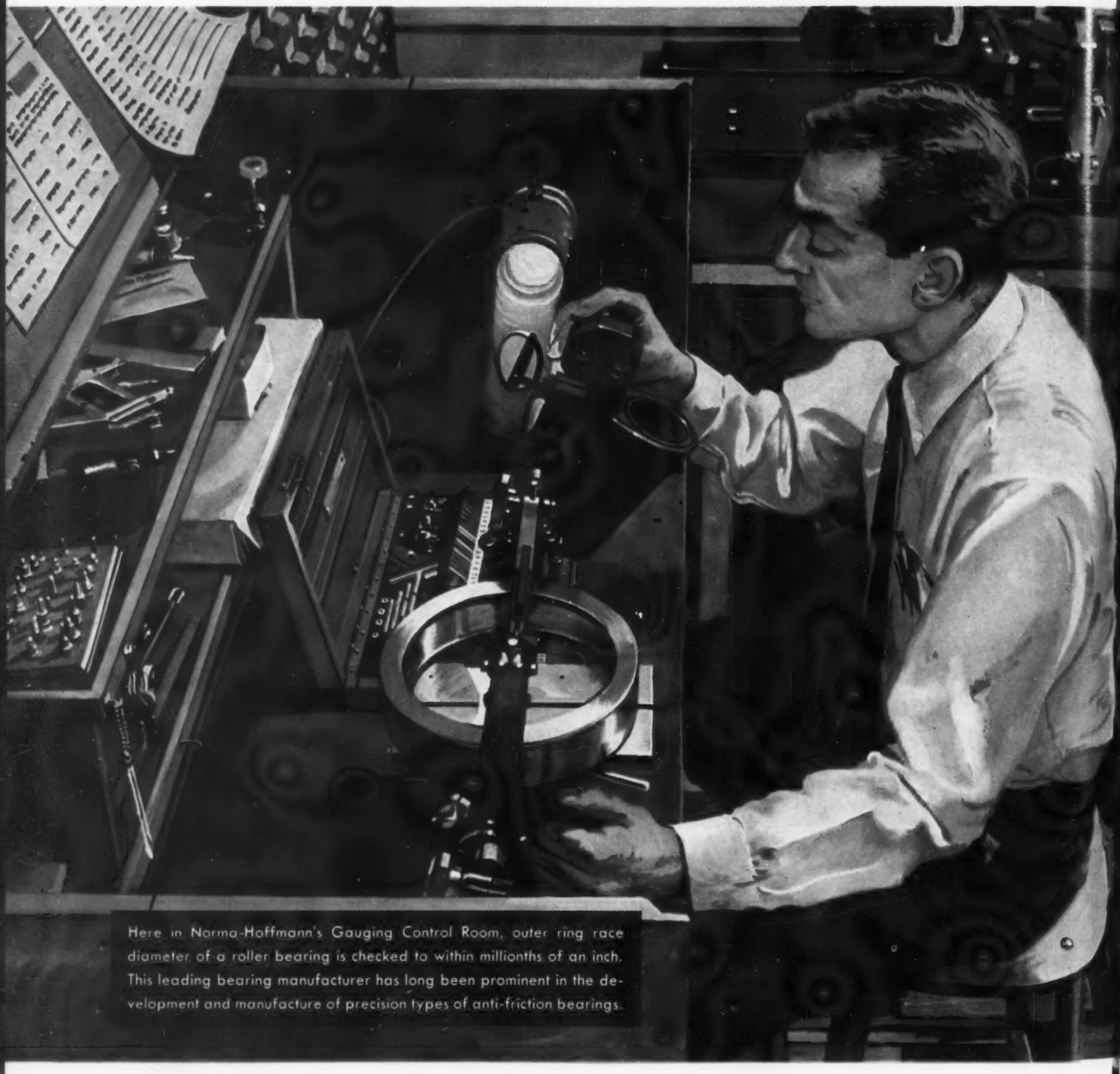
In Canada—Bailey Meter Company Limited, Montreal

Correct Lubrication in Action...

Bearing manufacturer



Here in Norma-Hoffmann's Gauging Control Room, outer ring race diameter of a roller bearing is checked to within millionths of an inch. This leading bearing manufacturer has long been prominent in the development and manufacture of precision types of anti-friction bearings.

Mobil

Complete Engineering Program
Proved Petroleum Products

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er rolls up $23,530 saving!

"In a growth company, we cannot afford to delay tomorrow's decisions while we stamp out today's brush fires. What plagues those of us in management are the myriad, small unknown-to-us problems that soar production costs, affect competitive position. This is where Mobil is helping us reduce manufacturing expense and improve production. Our 1958 records show that we saved over three times as much as we spent with Mobil last year . . . a most profitable relationship!"

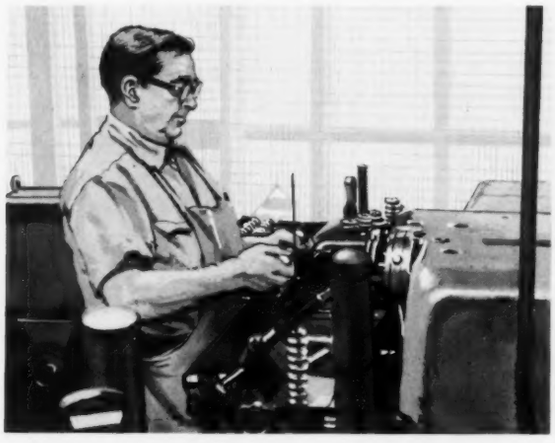
R. D. Robertson

Vice-President—Manufacturing
Norma-Hoffmann Bearings Corporation, Stamford, Conn.

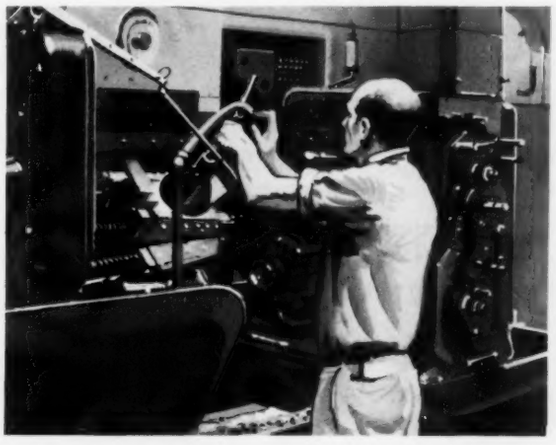
Mr. Robertson's words underscore the importance of Correct Lubrication to any profit-minded manufacturer. At Norma-Hoffmann Bearings Corporation Mobil lubrication engineers work closely with an extremely cost-conscious maintenance department. Downtime, parts replacements and maintenance costs have been cut—$23,530 saved in 1958 alone. Some of these savings are detailed below.

For example: Sticking valves on one grinder were a constant problem. Cause of the trouble was a mystery. Mobil's representative sent a sample of lubricant from the machine's reservoir to the Mobil laboratory. Analysis report led to cause of trouble—a lead sheathed cable submerged in the oil reservoir was contaminating oil. This detective work on the part of Mobil restored continuous production, saved $5,850 in maintenance costs.

This kind of practical engineering help is just a part of a Mobil program of Correct Lubrication. For complete details on how Mobil can improve your profits call your nearest Mobil representative. You'll find—You're Miles Ahead with Mobil!



Erratic, stick-slip operation of three grinders caused poor size holding. Mobil engineers found trouble was caused by deposits on valves and use of incorrect competitive oil. A correct way and hydraulic oil was installed. Greater production, fewer wheel dressings, less scrap and reduction in valve-cleaning costs saved $8,640.



To keep 16 of Norma's Multiple Spindle Bar machines functioning properly required a weekly 40-minute production interruption on each one to supply lubricant for tool slides. Mobil engineer studied procedure . . . suggested a simple lubrication system modification. Application time was reduced 75% . . . $7,040 saved on production and application.

il Correct Lubrication

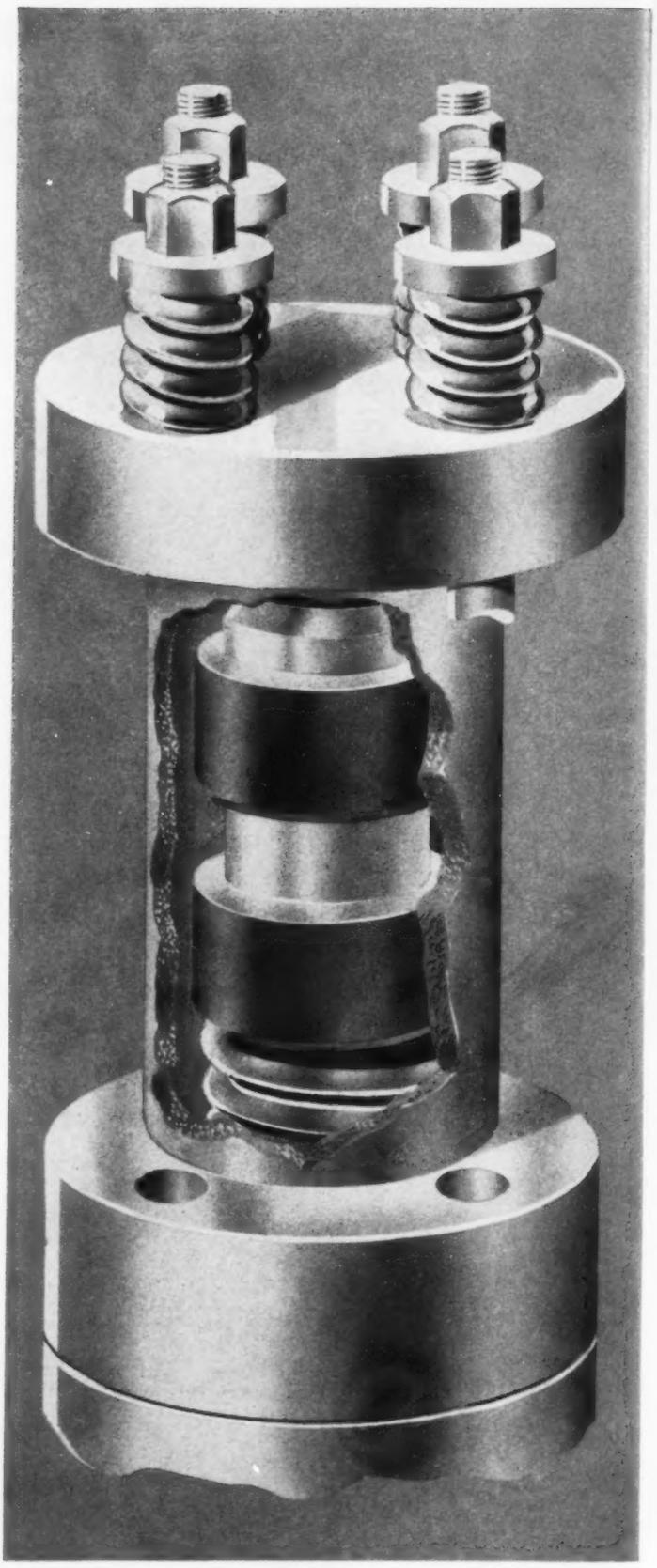
Another reason <u>You're Miles Ahead with Mobil!</u>

NOW KOPPERS LEADS AGAIN

by bringing you lower precipitator maintenance and operating costs with

K-30*

bonded pistons on pneumatic vibrators



By eliminating the need for lubrication of the rapping mechanism in electrostatic precipitators, Koppers saves you many operational man-hours and maintenance costs.

This lubrication-free operation results from bonding a new wear-resistant material to vibrator piston surfaces. This special self-lubricating compound, identified by Koppers as "K-30," is composed of Teflon† and other wear-resistant materials that together provide a self-lubricated surface.

Most rapping mechanisms demand regular maintenance to be trouble-free, but "K-30" eliminates this need and provides more reliable operation.

Koppers research, backed by many years of experience in the electrostatic precipitation field will help you find the answer to your gas cleaning problems. Check with Koppers to learn how "K-30" can develop top efficiency in present or planned precipitator installations. For more information, write: KOPPERS COMPANY, INC., 6806 Scott Street, Baltimore 3, Maryland.

*Koppers Trademark

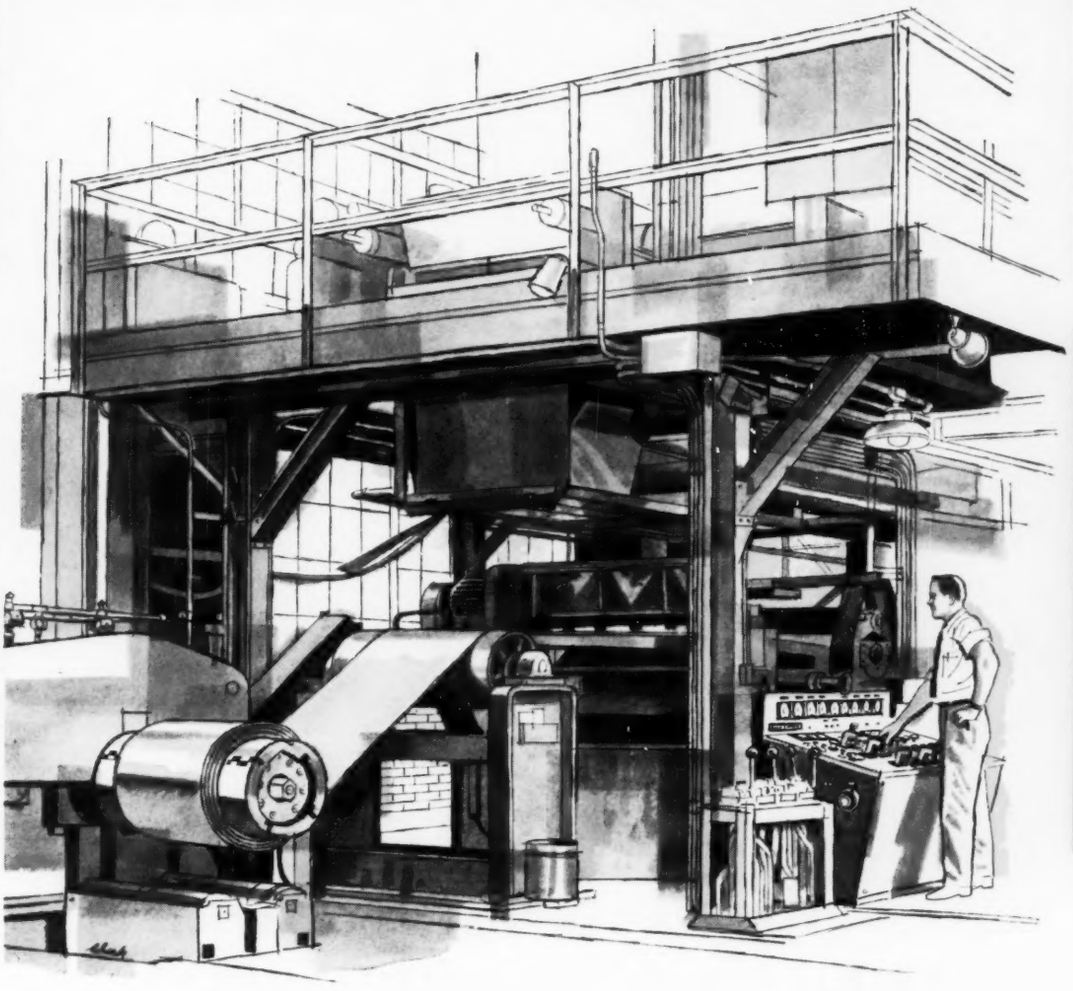
†E. I. duPont de Nemours & Company, Inc. trademark for tetrafluoroethylene resin

KOPPERS

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with *Service*

ALLIS-CHALMERS...in step with **STEEL**



3 Good Turns a Day

New control systems are an important key to higher efficiency, increased yield . . . 3 good turns a day.

Allis-Chalmers is working with steel mills all over the country. In many cases improvements in output and product quality are possible without major alteration of the mill.

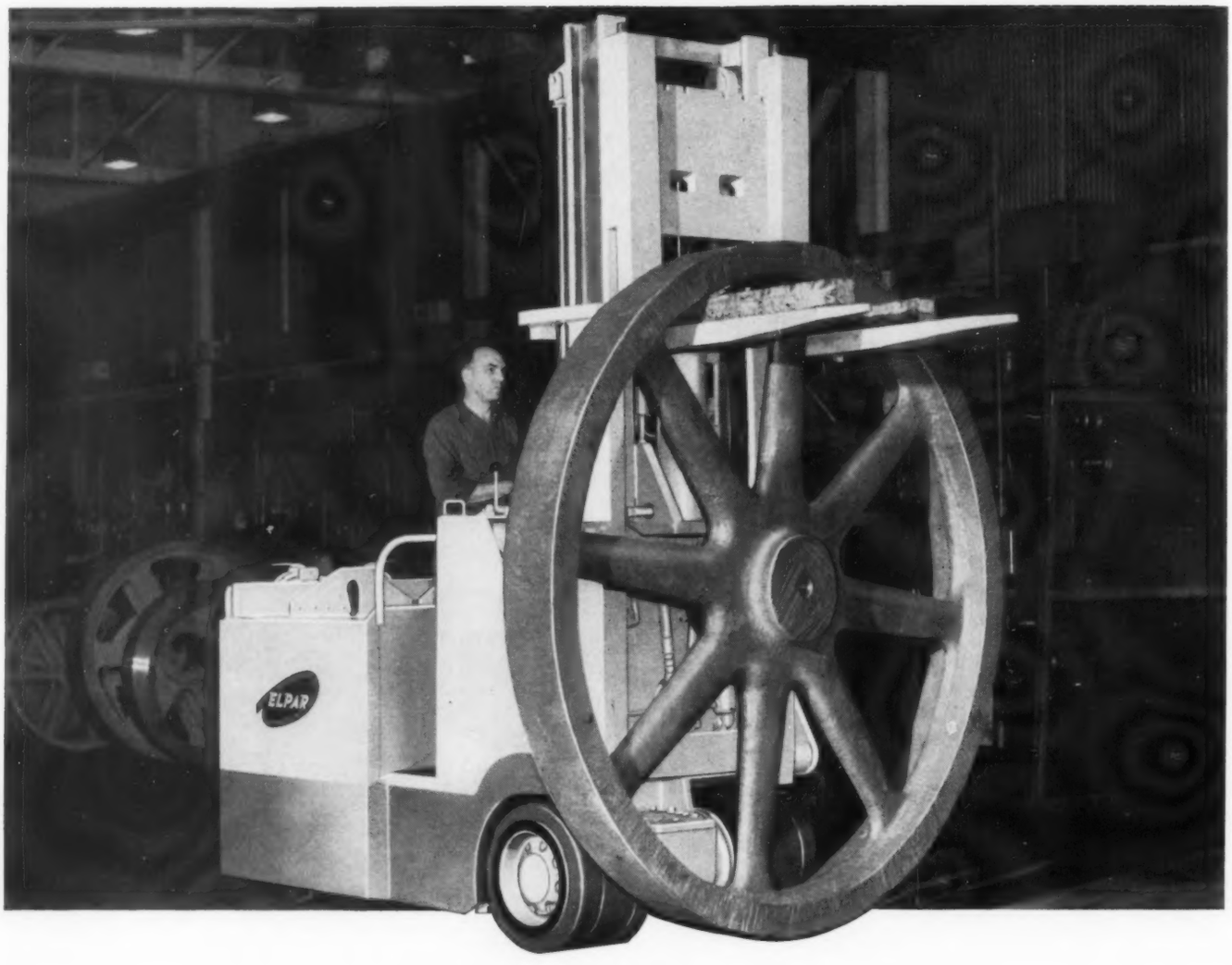
On the following pages you'll find information about Allis-Chalmers control, and other products A-C builds for the steel industry.

Talk your mill problems over with an Allis-Chalmers steel mill application specialist. Contact your nearby A-C office or Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

Plan to stay ahead... MODERNIZE!

ALLIS-CHALMERS A-C ALLIS CHALMERS

A-5968-1S



ELPAR'S New TITAN

. . . first BIG TRUCK with small truck maneuverability

No other truck in the 12,000 to 20,000 lb. capacity range can match the new TITAN for maneuverability. Built to operate through box car doors, the TITAN is ideal for car loading and for handling in narrow or congested aisles.

Other important features include:

TRI-SAFE BRAKING—an ELPAR safety exclusive that provides three independent braking systems operated by a single toe bar.

FASTER SPEEDS — fast lift and travel speeds plus rapid acceleration mean greater working efficiency.

UNEXCELLED VISION—elimination of bulky linkage gives the operator a clear view between the uprights.

As easy to operate as the family car, the new TITAN is the product of ELPAR's more than 50 years of industrial truck building experience. Compare features and you'll be convinced the TITAN is the best heavy duty fork truck buy!

5 models — 12,000 to 20,000 lbs. capacity

Send for this new TITAN folder —

ELPAR

ELECTRIC TRUCKS

THE **ELWELL-PARKER** ELECTRIC COMPANY

4549 ST. CLAIR AVENUE • CLEVELAND 3, OHIO

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TWICE THE LIFE . . . ONE-THIRD THE OPERATING COST

ALLIS-CHALMERS . . . in step with **STEEL**

Batteries of high speed electronic brains in Allis-Chalmers computing laboratory are helping answer a major problem facing all steel mills.

Computers Cut Shakedown Time

In the past a major cost factor of new motor and control has been the weeks of shakedown time required before operating at full production.

Typical problems solved before the rolls start turning are:

1. Analyzing electric drive for stability—ability to recover or settle out.
2. Computing values needed to set voltage regulators.

Solutions to problems are frequently designed into the equipment. Motor characteristics are established by the computer and regulators are coordinated with it.

Talk over your control and drive problems with Allis-Chalmers. Contact an A-C office or Allis-Chalmers, Milwaukee 1, Wisconsin.

Plan to stay ahead... MODERNIZE!

ALLIS-CHALMERS A-C ALLIS CHALMERS A-5965-15

Browning Bucket Crane Servicing Steel Mill Scale Pit

Other cranes in steel plant service include: skull-cracker, ladle reconditioning, soaking pit, open hearth charging, ladle-handling, motor room, gantry and others of special design. Lifting capacity range exceeds 200-ton rating.

"Simple Design is Sound Design"

SIMPLICITY . . . Minimum maintenance, easy accessibility.

RUGGEDNESS . . . Trouble-free service under severe condititons.

DURABILITY . . . Many years of reliable performance.

Your copy of the Browning catalog describing bridge cranes, trolleys and electric brakes will be sent upon request.

VICTOR R. BROWNING & COMPANY, Inc.

BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

ALLIS-CHALMERS...in step with **STEEL**

Plan to stay ahead... MODERNIZE!

An open motor did what no other motor could... in a mudbath

This Super-Seal motor with *Poxeal* insulation and protected bearing was not fouled by mud. An Allis-Chalmers customer, in a frequently flooded area, required a motor that could readily start even after prolonged immersion in mud.

The "dirtiest mud available" was used in conducting the successful tests in the A-C Motor Laboratories.

Motor user requirements like this form the basis for A-C pioneer-leadership in motor development. Motor buyer needs created the most complete line of integral-horsepower motors in industry. Induction, dc, wound-rotor, synchronous, gear, tube-type and *Synduction* motors, and now *Super-Seal* motors! And, if these lines don't fill your need, A-C engineering excels in special design.

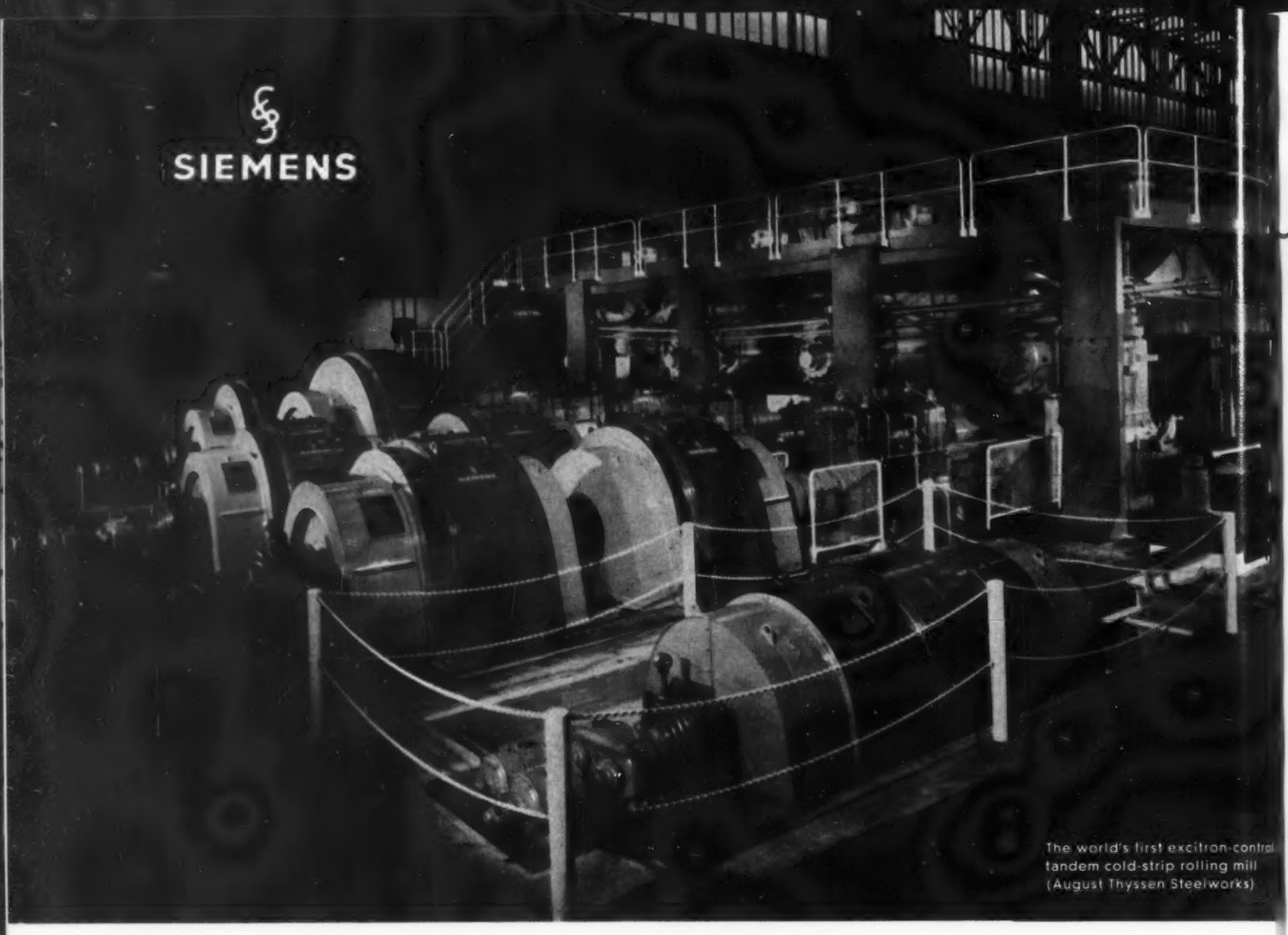
Motor users in the iron and steel industries can benefit from this pioneer-leadership. Contact your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

Super-Seal, Poxeal, and Synduction are Allis-Chalmers trademarks.

ALLIS-CHALMERS A-C

A-1005-IS

SIEMENS



The world's first excitron-control tandem cold-strip rolling mill (August Thyssen Steelworks)

Having considered all the pros and cons...

. . . you will agree that static-convertor-controlled drives are superior.

They are proving their worth from day to day.

Siemens static convertors are pumpless, grid-controlled steel-tank units of the excitron type. They can be controlled steplessly between the maximum positive and negative voltage limits, no matter whether the drive operates as a motor or as a generator. Thanks to the unitized system of construction plants can be assembled for any desired output.

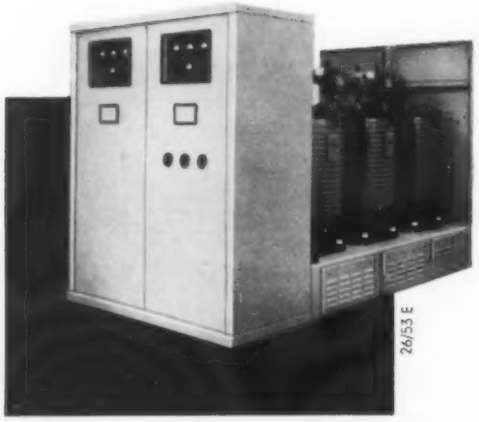
Here are some of the main advantages of the Siemens excitron convertors:

They require a minimum of floor space. Being light in weight, they need no expensive foundations and cranes.

They have no moving parts - consequently there is no bearing, brush or commutator maintenance. Only a minimum of spare parts need be kept in store.

Especially in conjunction with the recently developed transistorized control and regulating equipment the Siemens static convertors provide good, i.e. rapid and precise, control.

Any place, any time: Our experts are constantly at your disposal for advice on the planning and construction of rolling-mill drives.



Excitron convertor set with 6 single-anode tanks for d.c. voltages up to approx. 1,600 V and continous currents up to approx. 3,500 A (r.m.s.), maximum currents up to approx. 9,000 A (r.m.s.). Weight of a mercury-arc unit approx. 440 lb (200 kg) Weight of a complete convertor set approx. 6,600 lb (3,000 kg). Area of base 6 ft x 11 ft (1.8 x 3.3 m)

SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT

BERLIN · ERLANGEN

Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"THE WORLD'S BIGGEST CONTINUOUS CASTING PLANT FOR STEEL"

by V. V. FUL'MAKHT, E. M. KAN and A. F. CHUMICHEV, Central Research Institute for Ferrous Metallurgy. (Translation No. 4343 from Metallurg, June 1958, No. 6)

△ RESPONDING to the directives of the Twentieth Session of the Communist Party of the Soviet Union, Giprostal' (the State Institute for Designing Iron and Steel Plants), together with the Central Scientific Research Institute for Ferrous Metallurgy, designed a four-strand continuous casting machine.

This installation is being built at the Stalinsk iron and steel plant at Kuznetsk in Siberia. Carbon and low alloy steels will be cast from ladles of 154 net tons capacity simultaneously in four strands. The setup is designed to cast slabs of various cross-sectional areas ranging from $4^{23}/_{32}$ to $9^{27}/_{32}$ in. thick and 2 to 4 ft wide at a casting speed of 24 to 48 in. per minute.

Because of the condition of the ground and the necessity of insuring continuous operation of the open hearth furnaces, it was decided to sink a pit and to face it with reinforced concrete tubing.

The entire mechanism of the plant, consisting of four independently controlled machines, is installed in a circular pit about 81 ft in diameter. The casting platform is 9 ft-9 in. above shop floor level and the pit is 78 ft deep.

Four tundishes of about 15 tons capacity are installed on the casting platform on hydraulic turntable supports. Two of these tundishes are centered over the molds and two are held in reserve. The design of the turntable supports facilitates interchange of the tundishes and the casting of a subsequent heat as soon as the previous heat is finished.

Steel is transferred to four molds from two tundishes, each of which has two hydraulically controlled stoppers.

Before casting commences, a dummy bar is inserted at the bottom of each mold to serve as a temporary bottom. The dummy bar is in three parts and has a total length of 44 ft-9 in. and is of the same cross-sectional area as the slab to be cast. Before casting begins, the bottom of the dummy bar rests on the pinch rolls. As soon as casting commences, the pinch rolls begin to lower the dummy bar and withdraw the slab from the mold. As the dummy bar emerges from the pinch rolls, each part of it is automatically uncoupled and removed.

Emerging from the mold, the slab reaches the zone of secondary cooling. A roller apron is installed between the mold and the pinch rolls, embracing the entire length of the casting.

In the roller apron zone, the casting is spray cooled by water nozzles located in the gaps between the rolls. The total length of the secondary cooling zone is such that the slab reaches the pinch rolls with its core completely solidified.

Leaving the zone of secondary cooling, the slab enters pinch rolls designed to withdraw it at a given speed.

Beneath the pinch rolls are gas cutters designed to cut slabs, during casting, into lengths of 14 to 17 ft.

Cut lengths from the two machines are pushed onto a vertical elevator. The installation has two such elevators, one for each pair of machines. The elevators bring the slabs from the pit to shop floor level, where they are transferred to another runout table.

All the operations in the continuous casting plant are mechanized and automated. In the process of casting, the machine, with the exception of the gas cutters, is controlled from a control desk on the casting platform. The gas cutter controls are located on a platform below ground level. Control panels on the casting platform control each of the four strands independently. Recording instruments are attached to the control panels and it is proposed to set up a television screen for remote observation of operations.

"PRELIMINARY BLOWING OF HOT METAL IN LADLES WITH A STEAM-OXYGEN MIXTURE"

by YA. A. SHNEEROV, A. G. DERFEL', A. G. KOTIN, M. T. BUL'SKII and A. G. ALIMOV, Ukrainian Institute for Metals and AzovStal' Works. (Translation No. 4424 from Metallurg, August, 1958, No. 8)

△ IN 1957 the Ukranian Institute of Metals, in collaboration with the Azovstal' plant, carried out experiments on preliminary treatment of hot metal with oxygen in ladles.

One hundred and thirty ladles were blown including 114 ladles of high phosphorus and 16 of normal basic iron. The iron was blown in hot metal ladles through vertical 1-in. diameter cast iron lances immersed to a depth of 6 to 10 in. below slag level. Nine ladles were blown with straight oxygen while, in later trials, the hot metal was

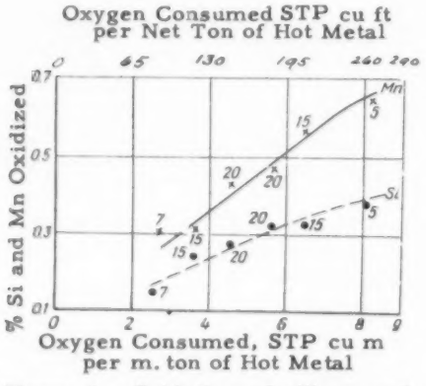


Figure 1 — Oxidation of silicon and manganese (during 45-min blow) as a function of volume of oxygen consumed.

blown with a steam-oxygen mixture containing 20 to 40 per cent by weight of steam. With such a ratio of steam to oxygen, the evolution of brown fumes was avoided.

Besides operating without any additions, tests were made with the addition of limestone and/or iron ore to the extent of 1 to 3 per cent.

The most notable drop in silicon and manganese content was observed when ore only was added. Sulphur was not reduced but actually increased somewhat. When limestone only was added silicon and manganese dropped much less, but sulphur fell very noticeably.

When mixed additions of limestone and ore were made, silicon and manganese dropped less than when ore only was added and more than when limestone only was added. Sulphur also dropped, but not to the extent as with limestone only.

OTHER AVAILABLE TRANSLATIONS

"Rating of Iron Ores from the Metallurgical Standpoint," W. Zimmer. Neue Hütte, vol. 3, 1958, No. 4. Importance of slag-forming substances present in iron ores and sinters for economical production of pig iron. Fundamental formula which makes allowance for blast-furnace smelting conditions and gives a correct, clear-cut rating of ore and sinter quality from the metallurgical point of view. Usefulness of formula. (Translation No. 4497)

"Flow Pattern in Continuous Casting Process," K. I. Afanas'eva and T. P. Iventsov. Stal', vol. 18, 1958, No. 7. Study of hydrodynamics of continuous casting [of steel], based on use of a model. Assumptions underlying the experiments, such as casting a 24 x 6 in. slab section. Experimental setup and procedure. Simulation of hydromechanics of pouring devices; modeling of motion of metal in continuous casting. Conclusions drawn from results as to best depth of liquid metal in tundish; stopper control of discharge through nozzles; open vs submerged jet stream; flow pattern in tundish; and in slab or billet; depth of penetration of air bubbles and jet stream into mold; best length of mold, etc. (Translation No. 4337)

"Effect of Cold Rolling and Heat Treating Conditions on Structure of Steel EI 428," E. Yu. Chemadurova. Metallovedenie I Obr. Met., Oct. 1958, No. 10. Study of changes in structure of a 0.10 C, 0.25 Mn, 1.60 Si, 6.0 Cr, 0.85 Al, 0.015 P, 0.006 S steel under various cold-working and heat-treating conditions to minimize its susceptibility to develop cracks in further processing (for example, into tubes). Results of x-ray and micrographic studies of effect of heat-treating practice upon structure. (Translation No. 4394)

"Development of Vertical Continuous Casting of Steel," by K. G. Speith and A. Bungeroth. Stahl und Eisen, vol. 76, 1956, No. 8. Report on continuous casting installations, operating problems and how they are being solved, and also on probable trends. Continuous casting from holding furnaces; increasing casting rates; casting from tilting vs stoppered ladles. Times required by metal to pass through mold, tabulated for thirteen continuous casting machines operating in Europe and North America, together with information on strand sizes and shapes, etc. (Translation No. 3835)

"Dust Precipitation by Sonic and Ultrasonic Vibrations," by A. Willner. [Slightly abridged translation from Bergbau-Technik, vol. 5, 1955, No. 4]. Critical survey of present status of precipitation of fine dust by acoustic means. Theory of agglomeration of dust by ultrasound. Equipment for generation of (ultra) sound: ultrasonic sirens; variation of sound intensity with frequency; Hartmann generator and variants. Nature of ultrasound: orthokinetic coagulation of dust particles; sound (radiation) pressure. Hydrodynamic forces: frequency; sound density; treating time; temperature; particle size and concentration. Technical installations. Plant constructed for experimental studies. Promise of large dust-precipitating plants where treatment and dust-precipitation chambers are in the same tower, the speed of travel of the aerosol in the individual sections being accurately matched and harmful eddies, avoided. Some data on capacity of ultrasonic dust precipitating plants. (Translation No. 4404)

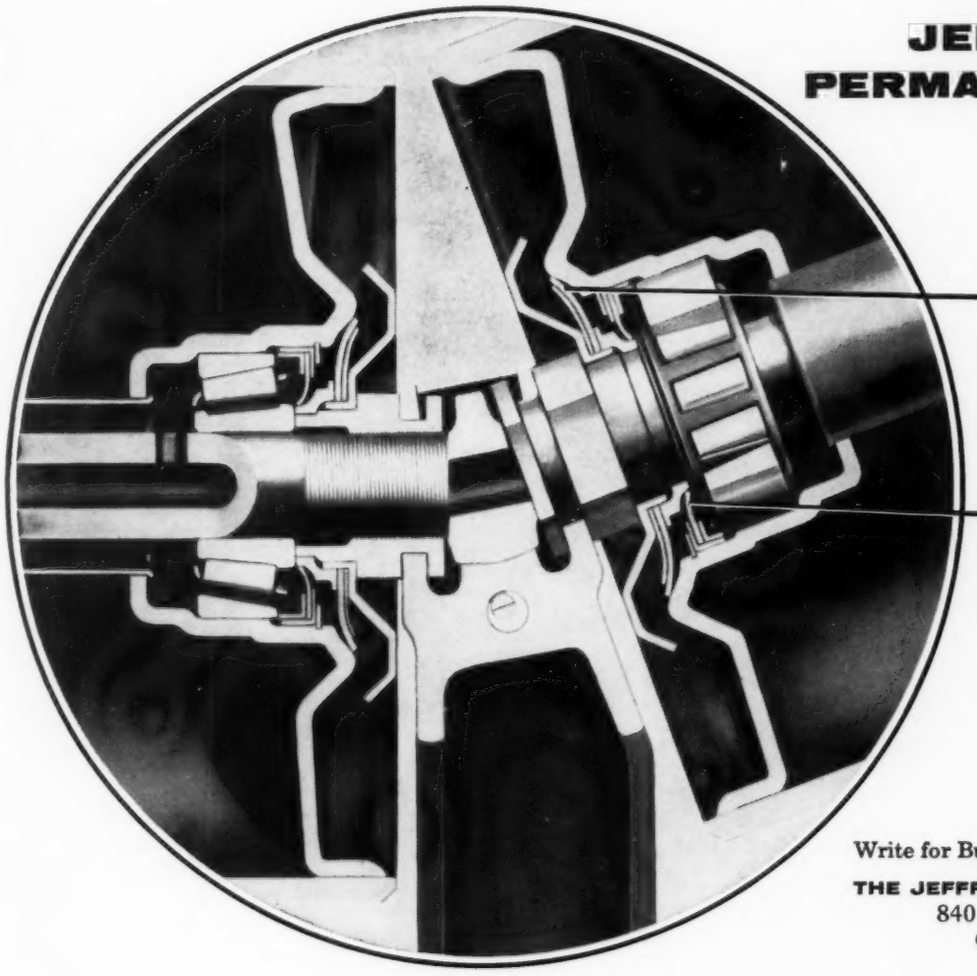
"Development and Industrial Application of Continuous Casting to Steel," by M. S. Boichenko, V. S. Rutes, and N. A. Nikolaev. Stal', vol. 16, 1956, No. 6. Fundamental variables, design features, and suitability of continuous casting machines for a wide range of steelmaking capacity. Particulars on mold; construction. Most favorable section shape of continuously cast product. Description of Novo-Tula one-strand continuous casting plant for 8 x 24-in. slabs, in operation since December, 1953. Description of Krasnoe Sormovo two-strand plant, operating since May, 1955. (Translation No. 3818)

"One lubrication every two years, more than sufficient"

Just part of the glowing report on the performance of Jeffrey PERMASEAL® Belt Idlers from the superintendent of Pennsylvania Railroad ore docks in Philadelphia. He further stated: "PERMASEAL Idlers have extended greasing periods from months to years." They have been on the job since November, 1953.

New seal construction, efficiently designed roller units, dependability, and long life combined with precision manufacture provide unmatched performance. You'll find Jeffrey idler design superior to anything offered today for belt conveyor service.

JEFFREY PERMASEAL® IDLERS



Magnified view of the heart of the PERMASEAL IDLER—shows double flexible diaphragm seals, bearings, and welded roll ends.

Write for Bulletin No. 925

THE JEFFREY MANUFACTURING CO.
840 North Fourth Street
Columbus 16, Ohio

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

NBD T-3 alloy kick-out screws cut rejects to a minimum at this transfer table

Now T-3 tests are setting new records in a wide range of hot guide and guide-roll applications.

Here's how it began. The continuous weld mills of Jones & Laughlin at Aliquippa had a problem to lick at the transfer table. Hot conduit shooting from the butt weld machine at 2000° F was building up hard scale on the iron kick-out screws—just enough to scratch and mar the tubing.

Aliquippa demanded constant top quality in the conduit they shipped . . . and that meant high rejection rates at the mills. An NBD Sales Engineer came up with a solution . . . based on NBD experience in a *glass factory!*

NBD had previously developed a special bronze mold alloy for the glass-container industry . . . one that would not stick to glass and would take all the thermal and mechanical shock of high-speed, high-temperature, glass-making operations.

Would the alloy work with steel?

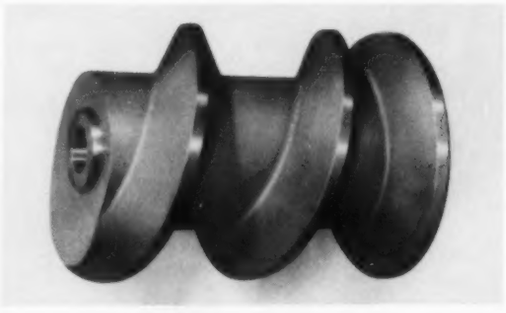
J & L personnel at the Aliquippa works decided it was worth a try . . . and ordered a trial set of kick-out screws made of the alloy for test in the No. 1 mill.

The alloy was NBD T-3 . . . and it worked perfectly with steel! No more surface marring of conduit. No more scale build-up. Kick-out screws actually tended to self-polish, giving a smoother performance with each pass. They lasted longer, showed less wear, cut costly maintenance and replacement to a minimum.

Today, T-3 alloy kick-out screws are in successful operation in both No. 1 and No. 2 mills at Aliquippa . . . helping to keep quality of conduit up, rejects down!

NBD alloy T-3 may be the answer to cost reductions in your plant . . . for entry guides, delivery guides, angle guides, roller guides, planishing rolls, tube-forming rolls and such.

Call in your nearby NBD Sales Engineer for a talk about T-3. Or send us an outline of your needs to NBD, 717-E Grant Building, Pittsburgh 19, Pennsylvania.



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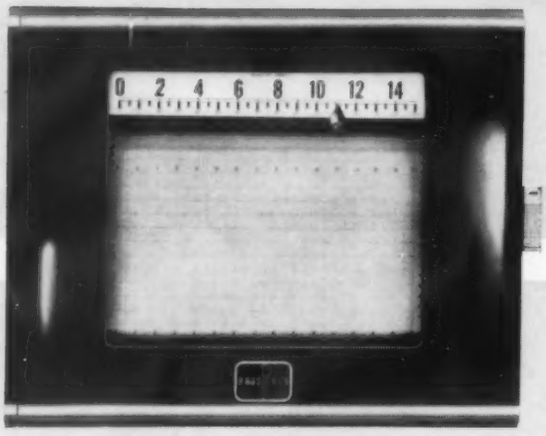
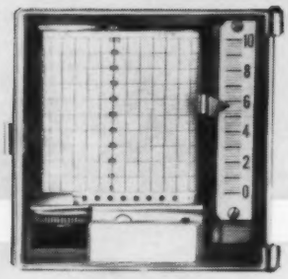
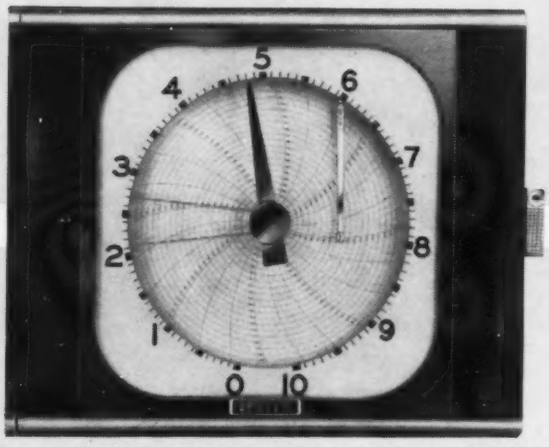


Dynamaster Electronic Potentiometer Pyrometer—Strip-chart model records on chart 11" wide, 120' long.



Miniature Electronic Dynamaster Pyrometer—Records on 3" strip-chart. Indicator model features easy-to-read 9" scale length.

Bristol Millivoltmeter Pyrometers—Free Vane* pyrometer controllers (shown) or indicating types. Many control modes available.



Dynamaster Electronic Potentiometer Pyrometer—Round-chart model records on 12" chart, indicates on extra large scale.

MODERN PYROMETERS...key to profitable use of HEAT

Bristol recording and automatic controlling pyrometers for temperatures up to 5000°F can help you increase product uniformity, cut fuel and maintenance costs

Bristol makes a wide range of pyrometers for every requirement: Electronic potentiometers, millivoltmeter and radiation types . . . for furnaces, ovens . . . every type of heating equipment, every kind of fuel. The reliability and accuracy of these precision instruments have been proved in thousands of installations.

Take just one advanced Bristol instrument, for example, the Electronic Dynamaster* Potentiometer Pyrometer:

CONTINUOUS STANDARDIZATION PLUS ACCURACY OF STANDARD CELL

Continuous standardization in Dynamaster Electronic Pyrometers requires no dry-cells, **but still retains the precision standard cell for highest stability and accuracy of voltage reference.** Results: No interruption to operation, no batteries to change. And here are just a few of the Dynamaster types available:

A model for every requirement: Dynamaster Pyrometers are available as single-pen, two-pen, and multiple-record (up to 24 points) *strip-chart* instruments and as *round-chart* instruments.

Electric and pneumatic controllers: Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every furnace and oven control requirement, including the following in a great many forms:

Electric Control—on-off, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

Pneumatic Control—on-off, proportional, and proportional with reset.

Miniature Dynamaster Pyrometer: Full plug-in flexibility . . . takes only 5" x 5⅛" of panel space, but has same basic accuracy, same time-tested operating principle as full-size Dynamaster pyrometers described above. Ideal for graphic panels and centralized recording or indicating of large numbers of variables. Either electrical or pneumatic control types available.

Write for complete data on Bristol Pyrometers—and remember Bristol offers a complete line of thermocouples and pyrometer accessories. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. *T.M. Reg. U.S. Pat. Off. D-9

BRISTOL... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Pecor Hot Metal Mixers in U. S. Steel's Geneva Works, Utah.

35-Ton Oxygen Converters by PECor in operation at McLouth Steel Corporation.

UNIFORM IRON FOR CONVERTER PROCESSING

When you plan an expansion or modernization of your Bessemer or oxygen converter shop, plan on a PECor Hot Metal Mixer for ample storage, hotter iron and uniform analysis.

Recent tests made in Europe, which introduced radioactive isotopes to the ladle before addition to the mixer indicate that mixing takes place by the "in-pouring" action and that relatively uniform iron analysis is the result.

For the experienced "know-how" that assures sound installations . . . ahead-of-the-field design and completely cooperative engineering—look to Pennsylvania Engineering.

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This 40-page fully illustrated catalog covers some of the major projects completed by PECor. Yours without obligation.

PECOR

STEEL PLATE FABRICATORS ASSOCIATION

PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PENNA.

Sales Representatives

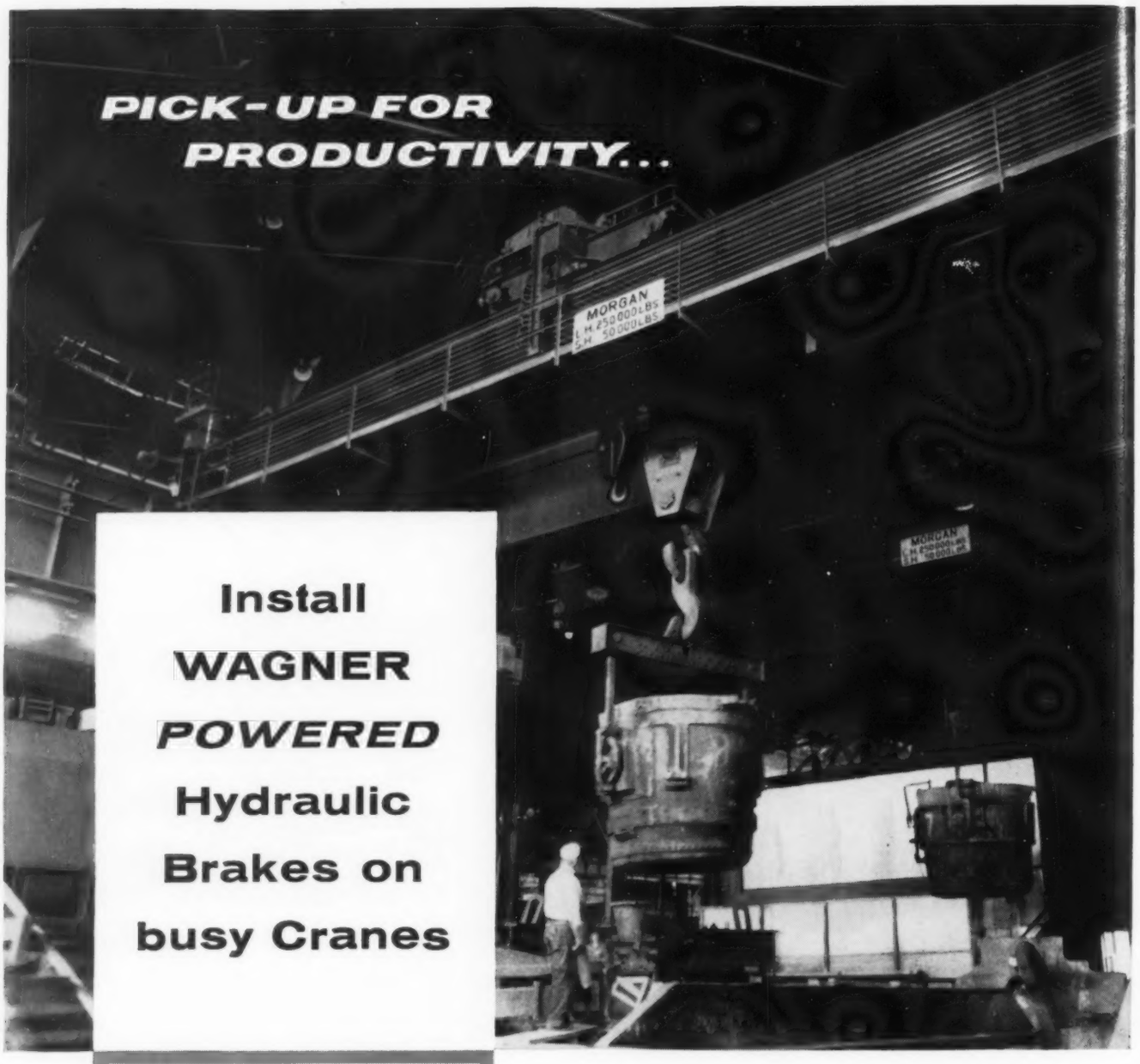
Wooldridge Co., Burlingame, Cal. Fred Middleton Co. Inc., Birmingham, Ala.

OTHER STEEL PLANT EQUIPMENT WE BUILD

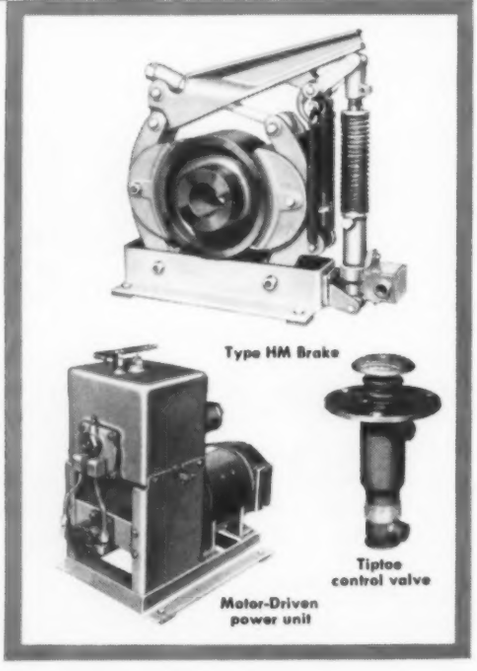
Blast Furnaces • Scrap Cars • Slag Cars • Oxygen Converters • Bessemer Converters • Hot Metal Mixers • Ore Transfer Cars • Ladles • Jack Cars • Ladle Transfer Cars • Ingot Cars • Mixer Cars • Thermo Metal (Bottle) Cars • Scale Cars

ENGINEERS • FABRICATORS

PICK-UP FOR PRODUCTIVITY...



Install WAGNER *POWERED* Hydraulic Brakes on busy Cranes



Some of your cranes are VIP's (very important producers). You can increase productivity by equipping these busy cranes with Wagner *Powered* Hydraulic Crane Bridge Brakes.

Powered hydraulic braking gives safer, more efficient operation where frequent starts and stops are necessary . . . where close spotting is required . . . where heavy equipment is involved . . . for any extra busy heavy crane.

Your operators perform more efficiently, too, because there's far less fatigue. The operator stops the crane with the easy touch of a toe on a button while his heel rests comfortably on the floor. Several brakes can be operated from one pedal.

These power units can be added to your present Wagner Hydraulic System. Let your nearby Wagner Sales Engineer tell you how easy, fast, and economical such an installation can be. There are Wagner branches in 32 principal cities.

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Missouri.

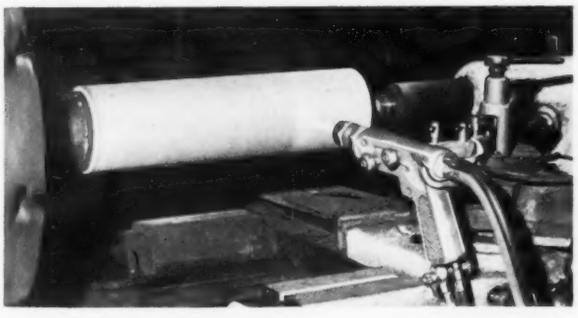
W159-4

SERVING 2 GREAT GROWTH INDUSTRIES... *ELECTRICAL... AUTOMOTIVE*

SPRAYWELD® Hard Surfacing Cuts Journal Costs

Table roller journal sleeve maintenance costs were cut from $21.06 to only $1.50 each per month through the use of the Colmonoy Spraywelder (reports the September 1957 issue of *Iron and Steel Engineer*). The Spraywelder, a universally accepted powder metal spraying unit, applies Colmonoy hard-surfacing alloys to provide low-cost protection against abrasion, impact, heat, and corrosion.

The Colmonoy Spraywelder sprays powdered Colmonoy alloys to form smooth, even overlays. The overlays are then fused to the part, forming an integral surface of wear-resistant alloy. Write now for complete information about this versatile maintenance tool.

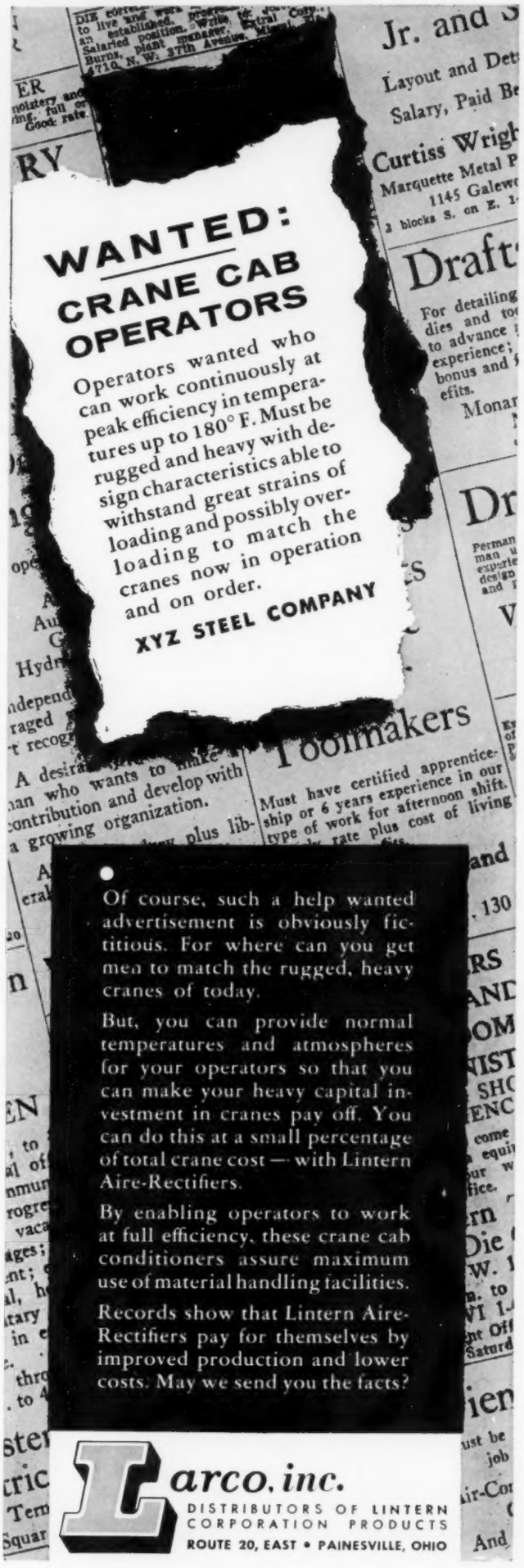


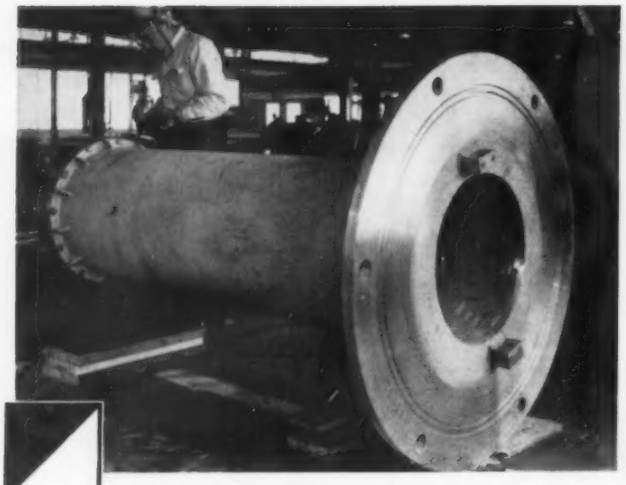
Journal sleeves are made of low carbon seamless steel tubing, with an overlay of Colmonoy No. 6 hard-surfacing alloy, applied by the Spraywelder. The sleeve is rotated in a lathe, with the Spraywelder mounted in a tool-post holder.

HARD-SURFACING AND BRAZING ALLOYS

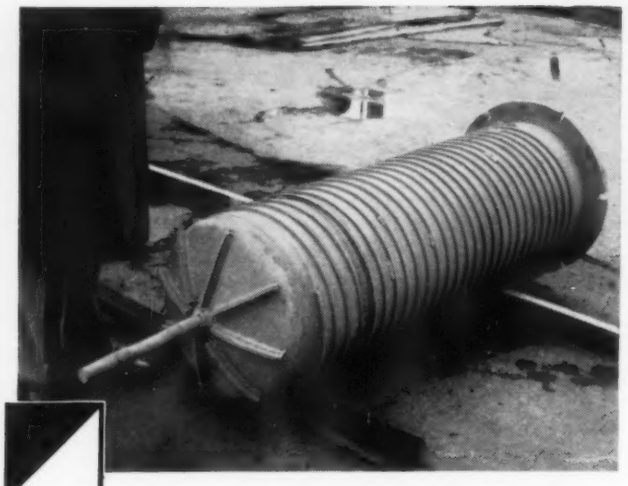
WALL COLMONOY
CORPORATION
19345 John R Street • Detroit 3, Michigan

BIRMINGHAM · BUFFALO · CHICAGO · HOUSTON · LOS ANGELES
MORRISVILLE, PA. · NEW YORK · PITTSBURGH · MONTREAL · GREAT BRITAIN

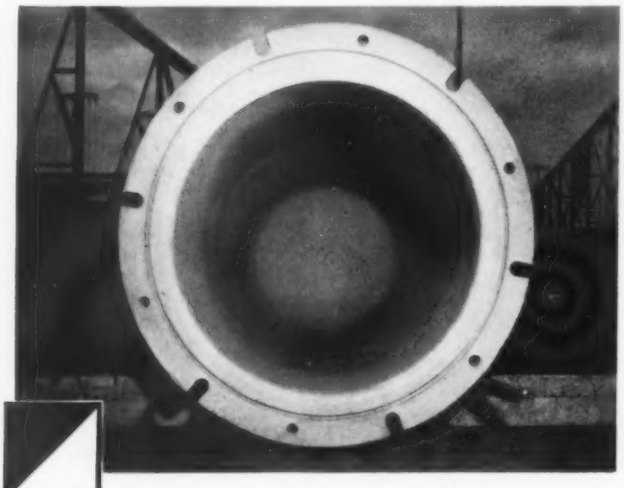

WANTED:
CRANE CAB OPERATORS
Operators wanted who can work continuously at peak efficiency in temperatures up to 180° F. Must be rugged and heavy with design characteristics able to withstand great strains of loading and possibly overloading to match the cranes now in operation and on order.
XYZ STEEL COMPANY
Toolmakers
Must have certified apprenticeship or 6 years experience in our type of work for afternoon shift.
Curtiss Wrigh
Marquette Metal P
1145 Galewo
Draft
Layout and Det
Salary, Paid Be
Salaried position. Write
Burns, Plant manager,
4710 N. W. 37th Avenue,
Good rate.
Jr. and
For detailing
dies and to
to advance
experience;
bonus and
efits.
Monar
Perman
man u
experie
design
and
man who wants to
contribution and develop with
a growing organization.
plus lib-
Of course, such a help wanted advertisement is obviously fictitious. For where can you get men to match the rugged, heavy cranes of today.
But, you can provide normal temperatures and atmospheres for your operators so that you can make your heavy capital investment in cranes pay off. You can do this at a small percentage of total crane cost — with Lintern Aire-Rectifiers.
By enabling operators to work at full efficiency, these crane cab conditioners assure maximum use of material handling facilities.
Records show that Lintern Aire-Rectifiers pay for themselves by improved production and lower costs. May we send you the facts?
Larco, inc.
DISTRIBUTORS OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO



23" Diam. Copper Crucible for Vacuum-Melting of Steel, completely fabricated and machined, ready for installation.



Copper Mold with Water-Circulating Ribs.



Copper Mold for Melting Titanium.

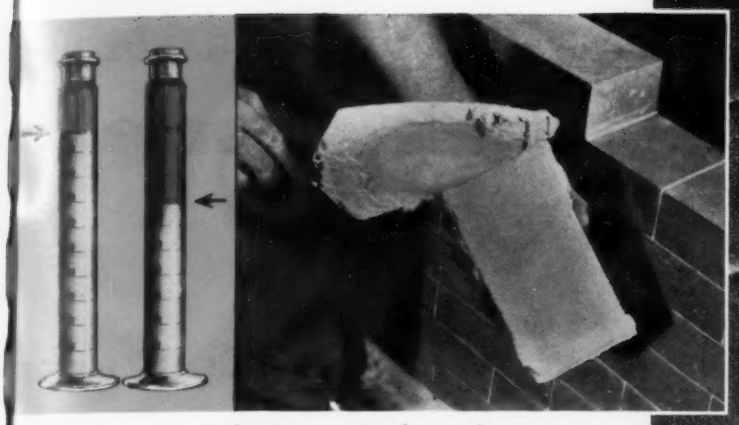
Welding Copper Ribs on Heads for Copper Crucibles.

VACUUM MELTING CRUCIBLES BY WELDCO

FOR TITANIUM AND ALLOY STEELS

We have had extensive experience in making Copper Molds, Jackets, and Furnaces for Vacuum-Melting of Alloys. Progressive producers are boosting their quality sharply by using the Vacuum-Melting Process. Why not investigate the possibilities?

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3805 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO



1. Settling test (as shown) demonstrates that ANKORITE 65 remains longer in suspension, a valuable characteristic of a hot-setting mortar. ANKORITE 65 in the graduate on the left, shows no settling, while ordinary mortar in the other tube has settled considerably in the same time.
2. ANKORITE 65 spreads smoothly and well, making uniform joints of the thickness desired.
3. View of malleable furnace wall of high-quality super-duty fireclay brick laid with ANKORITE 65. The unusual resistance of this mortar to severe slagging action and erosion is illustrated by the joints which extend beyond the brick.

Harbison-Walker Ankorite 65

The new WIDELY-USED bonding mortar • more refractory • more workable • more durable • for super-duty and high-alumina brick

The protruding mortar joints of the furnace wall in the photograph illustrate the exceptional durability of ANKORITE 65. This shows a portion of a malleable furnace wall of high-quality super-duty fireclay brick laid with this mortar. As is obvious, after the normal period of service, the mortar has been less eroded than the brick.

ANKORITE 65 is a high-alumina heat-setting mortar which develops a strong ceramic bond of high resistance to slag corrosion and to severe erosion of metal and slag at high temperatures.

ANKORITE 65 is used with splendid results for laying bottom blocks and linings of blast furnaces up to the mantle. It is particularly suited for laying various alumina-silica brick linings of transfer ladles, for electric furnace roofs, and for malleable and air furnace side walls and bottoms. The good workability of this mortar lends itself to easy trowelling or dipping in securing strong impervious joints. In some applications it is used with benefit for protective coatings by spraying or brushing.

The Garber Research Center

Leadership in refractories through constant research

Harbison-Walker Refractories Company

AND SUBSIDIARIES *World's Most Complete Refractories Service*

GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA

From GPE Controls . . . first e
specially designed for modern hi

The new **GPE Controls** R465 Electronic Controller is planned for high performance in every aspect... the result is the highest degree of dynamic accuracy possible. Three times as fast as other known control systems, yet comparably priced. With GPE Controls transmitters and valve actuators, precise control can be maintained at more than 20 cps. Easy, low-cost installation, because high-level d.c. signal makes possible simple unshielded wiring. Instant visual comparison of parallel set-point and process variable indicators. Engineered for simplified maintenance. Another first from the first name in electro-hydraulic control systems.

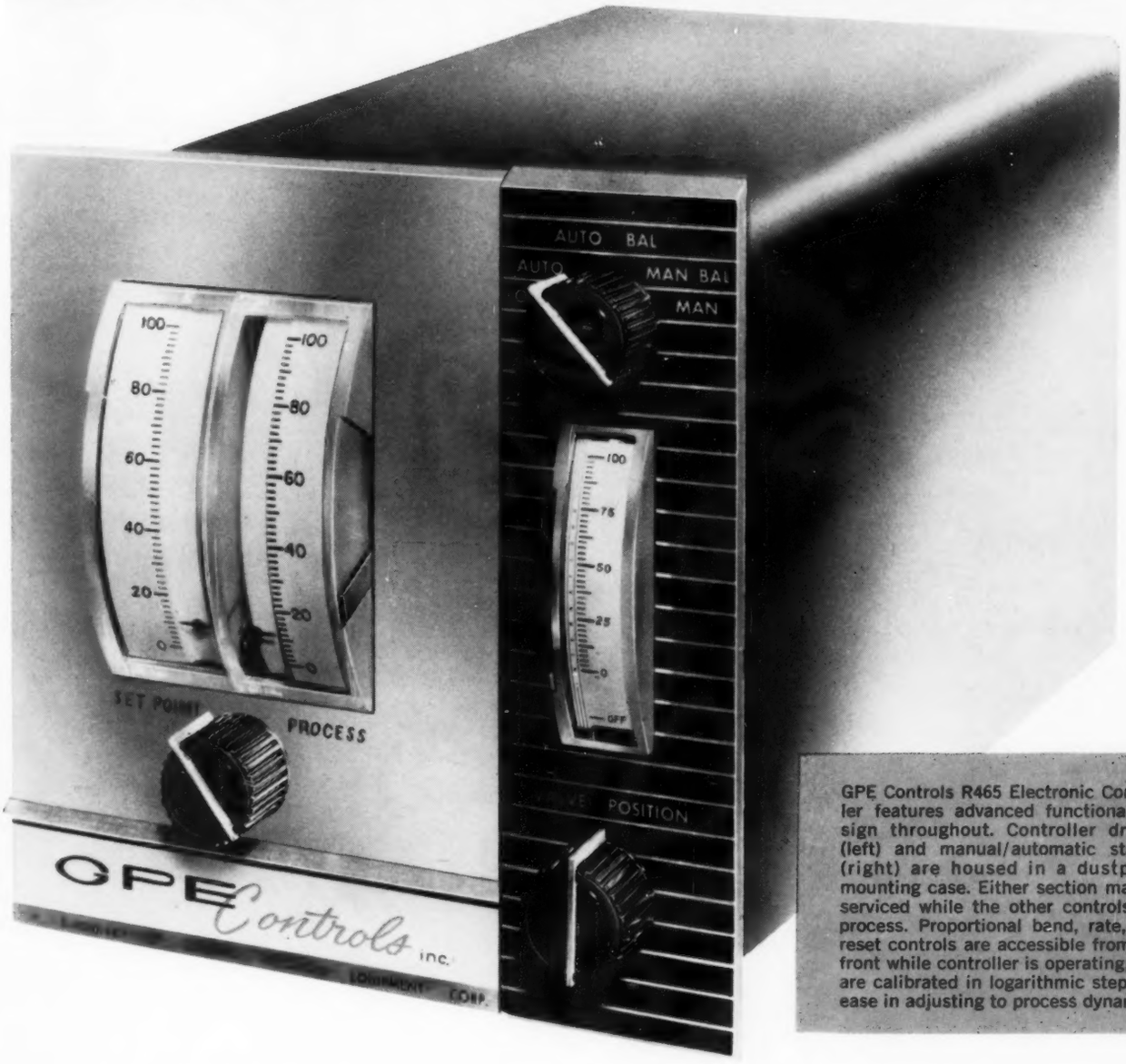
GPE Controls | A GENERAL PRECISION COMPANY

NEW factual bulletin tells the "how and why" of electronic control. Write for your copy today!

GPE Controls, Inc. (formerly Askania Regulator Company)
240 East Ontario Street • Chicago 11, Illinois

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

electronic controller high-performance systems!

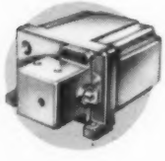


GPE Controls R465 Electronic Controller features advanced functional design throughout. Controller drawer (left) and manual/automatic station (right) are housed in a dustproof mounting case. Either section may be serviced while the other controls the process. Proportional band, rate, and reset controls are accessible from the front while controller is operating; and are calibrated in logarithmic steps for ease in adjusting to process dynamics.

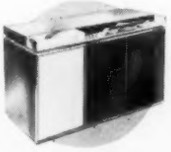
Matched High-Performance Control Components by GPE Controls

Electro-Hydraulic Valve Actuator
Completely self-contained units, matched to other GPE Controls components, sized to meet 90% of all control valve applications.

Rotojet® Electro-Hydraulic Servo Valve
Single-stage simplicity with multi-stage performance. For larger valves and high speeds.



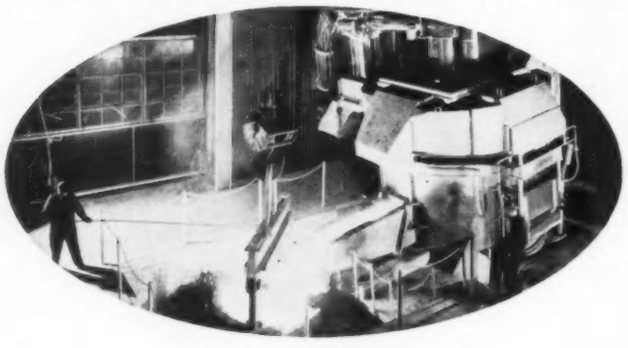
Pressure/Flow Transmitters
Lowest differential pressure requirement of any transmitters. Automatic square root extraction available for straight summarization, high accuracy at low flow rates.



Libratrol-500 Digital Control Computer
Designed expressly for industrial automatic control applications. Simple, proved, moderately priced.

WHEELABRATOR'S WIDE-ANGLE VIEW

stifles the most stubborn electric furnace fume



In 27 prominent steel producing plants, Wheelabrator Dustube® Collectors handle a combined total of nearly a million c.f.m. of air from 48 electric furnaces.

From the vantage point of this unequalled experience in controlling electric furnace fume, Wheelabrator takes a "wide-angle" view that solves the most formidable problems of hooding, ventilating, and fume collection.

Wheelabrator Dustube systems regularly achieve highest collection efficiencies (nearly 100%), meet the most stringent air pollution codes, and do so with maximum economy of installation and operation of the system.

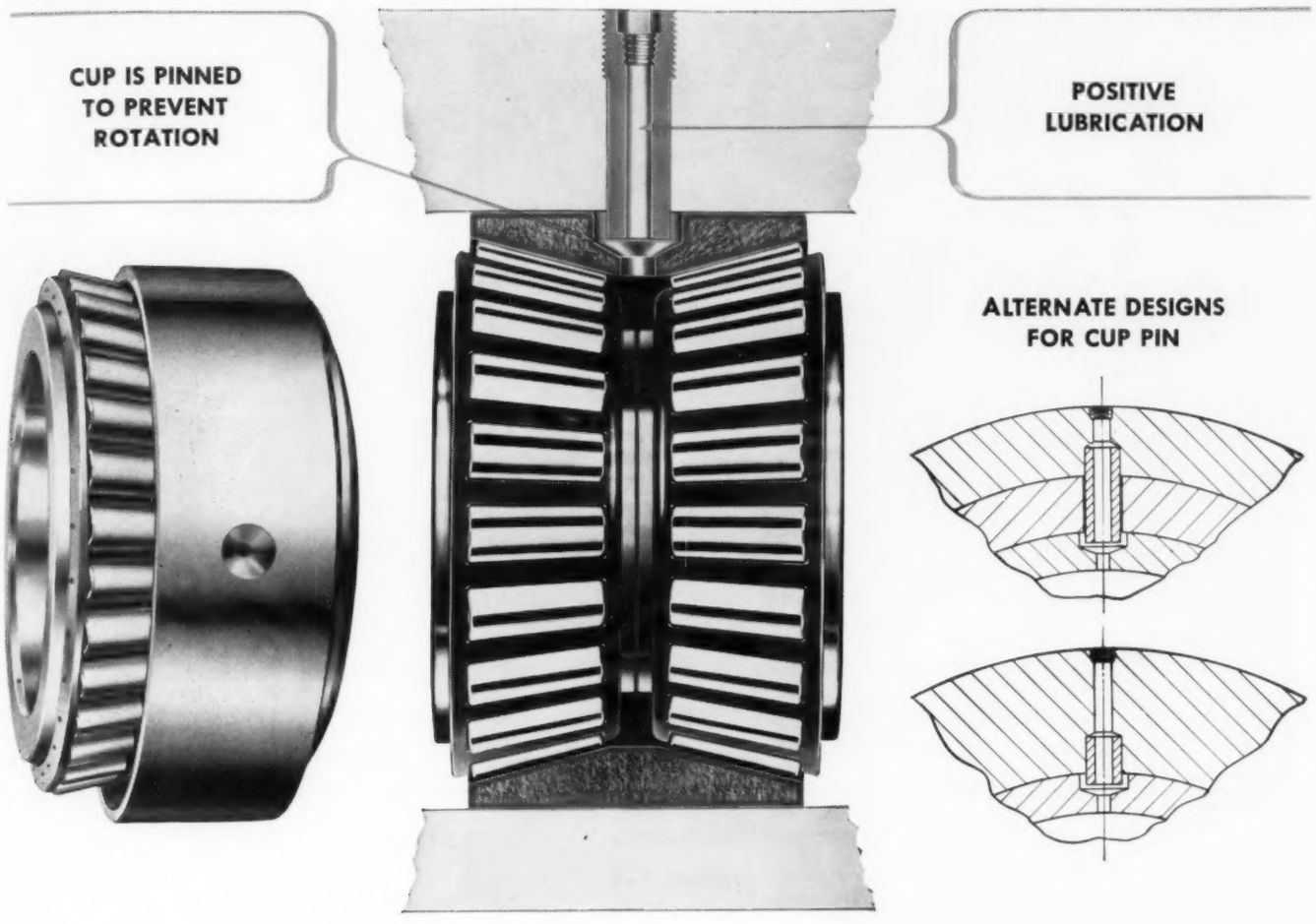
Another plus value inherent in a Wheelabrator fume control system is the wide choice of cloth and synthetic filter fabrics available — including Orlon, Dacron, and the new Glastube glass fabric filter bags.

Take advantage of Wheelabrator's unmatched knowledge of electric furnace fume control. Write today for complete information.

A Sound-Color Film on Electric Furnace Fume Control is available for showing to interested firms. Write for details.

WHEELABRATOR
DUST AND FUME CONTROL

WHEELABRATOR CORPORATION
396 South Byrkit Street Mishawaka, Indiana
Canadian Div. — P.O. Box 490, Scarborough, Ont.



NOW! A double-row bearing for any floating position

REDUCES WEAR AND POUNDING
PROVIDES FOR POSITIVE LUBRICATION

Now you can get a new Timken® bearing—first of its kind developed for floating bearing positions—that answers the problem of excessive wear from creeping and pounding in gear drives, spindles and many other applications. It's a pin-cup, double-row tapered roller bearing. Manufacturers can assemble and adjust gear drives, then merely set the pin. Result is a bearing that floats endwise but cannot turn in the housing. It greatly reduces wear, provides for continuous, positive lubrication. This new Timken bearing gives you all these advantages for those applications where there is an inherent tendency for the cup to creep or turn in the housing.

1) *Positive lubrication* because oil is fed continuously through the pin.
2) *Longer bearing life* because bearing creep is eliminated. Related parts are better protected, too.

This new pin-cup bearing results from Timken bearing research and development. Research to make machines perform better at lower cost. And the combined, new $2½ million engineering and research facilities of the Timken Company, unique in the industry, make progress like this possible. Make it yours when you use Timken bearings in the machines you build or buy. Another reason why "Timken" is your No. 1 bearing value. The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.

WHEN YOU BUY TIMKEN® BEARINGS YOU GET...

1. Quality you can take for granted
2. Service you can't get anywhere else
3. The best-known name in bearings
4. The pace setter in lower bearing costs

BETTER-NESS rolls on

TIMKEN®

tapered roller bearings

This symbol on a product means its bearings are the best

Interested in Oxygen? Nitrogen? Argon?

Here's Why "Big Three" For its New Fort

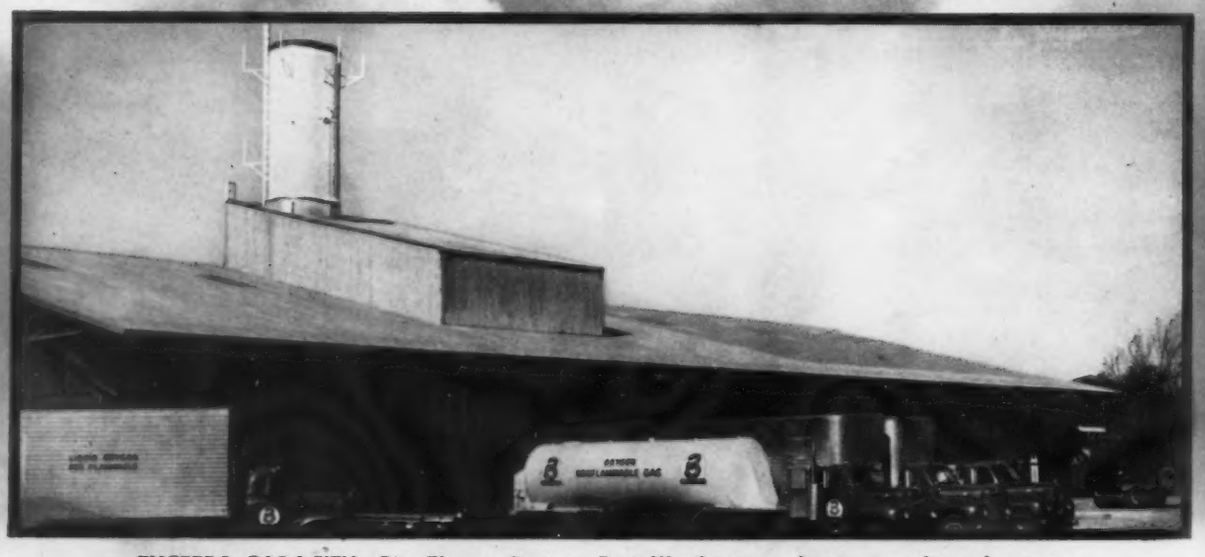
A leading oxygen producer in the Southwest, Big Three, considered very carefully its choice of an engineering firm to design and provide the equipment for a new tonnage plant for the Dallas—Fort Worth area.

That's why they selected Messer for the job!

Messer's long background in this country and abroad has established its reputation as a sound and reliable supplier of air separation plants of all types. In the past two years, Messer has been particularly successful in designing and engineering oxygen-producing equipment of the type Big Three wanted.

HOW IT WORKED OUT

Now that the Messer plant is "on stream" in Fort Worth, what are the results? To quote Mr. C. K. Rickel, Big Three president:



EXCEEDS CAPACITY—Big Three plant at Fort Worth runs above capacity whenever necessary; works efficiently and economically.

Chose MESSER Worth Oxygen Plant

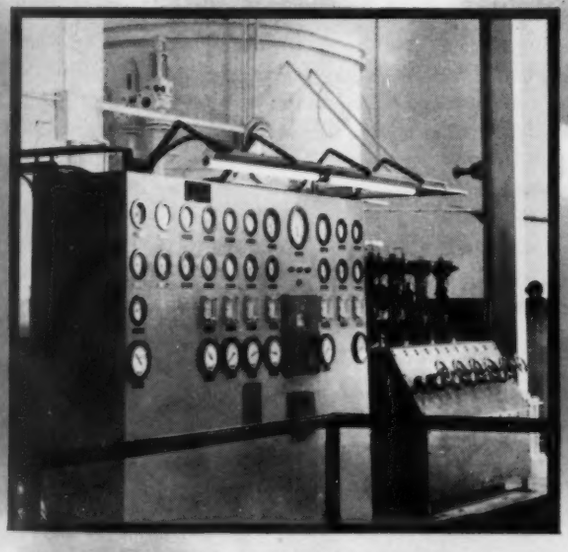
"We are more than pleased with the Messer unit that we installed last summer. It is making its full capacity of oxygen, nitrogen, and argon very efficiently. I would be happy, indeed proud, to show anyone through this plant."

Can *your* business benefit by the installation of tonnage oxygen, nitrogen, or argon producing equipment? If so, be sure to consult American Messer. Your inquiry will be welcomed!

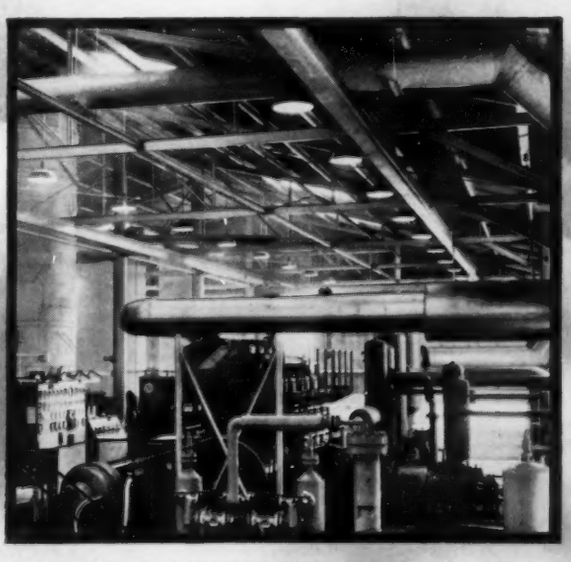
AMERICAN MESSER CORPORATION

Chrysler Building • 405 Lexington Avenue • New York, N.Y.

THERE IS NO SUBSTITUTE FOR MESSER EXPERIENCE



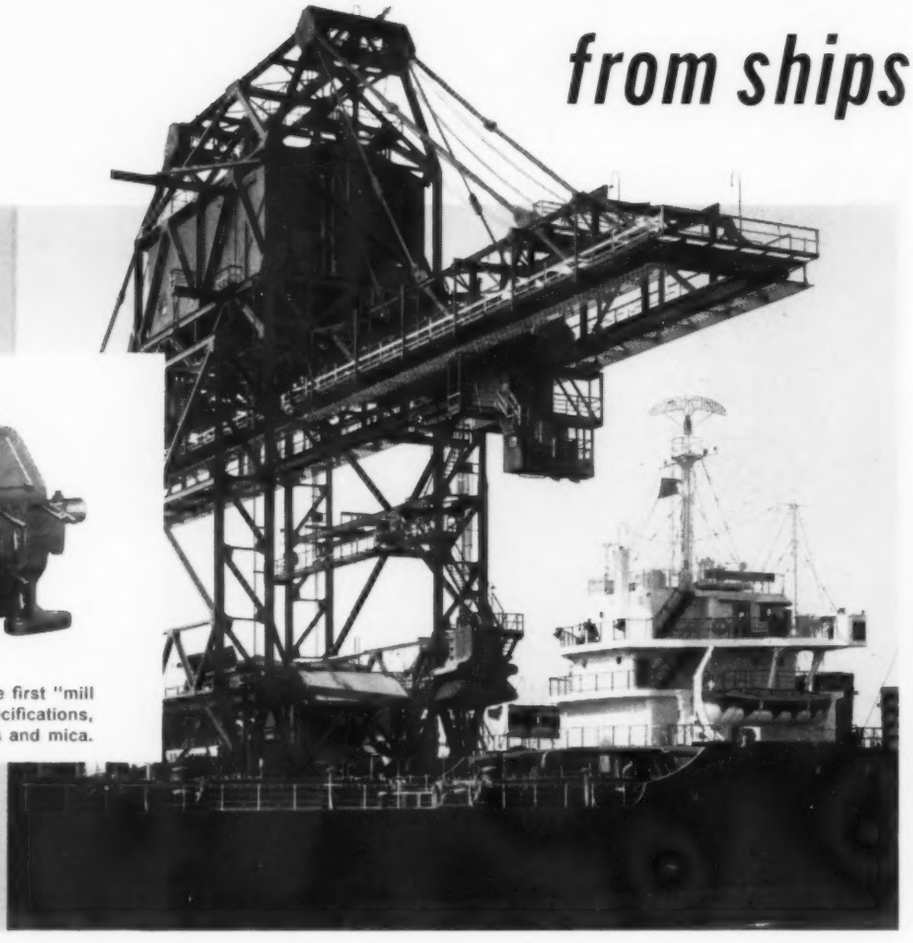
ONE OPERATOR PER SHIFT—Extensive use of automatic controls in Big Three unit requires little attention —only one operator.



REAL POWER ECONOMY—Power for this installation is furnished by an inexpensive natural gas engine—yields products at low cost.

from ships

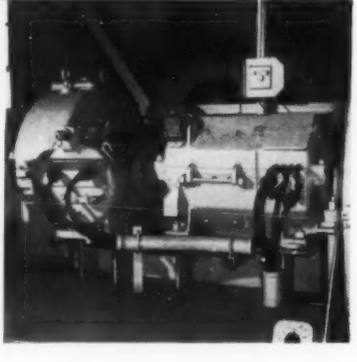
In 1904, Crocker-Wheeler introduced the first "mill type" motor—built to steel men's specifications, bull-strong, and insulated with asbestos and mica.



ELLIOTT C-W MOTORS

Above: Driving the trolley turntable is this Elliott 603 frame, 13¼-hp mill motor, seen in the foreground. In the background is one of the Elliott 616 frame, 187½-hp motors which power the trolley.

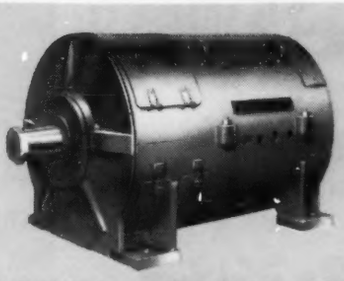
Right: One of the Elliott 612 frame, 94-hp, series-wound, adjustable-voltage mill type motors which drive the apron hoist in this gigantic operation.



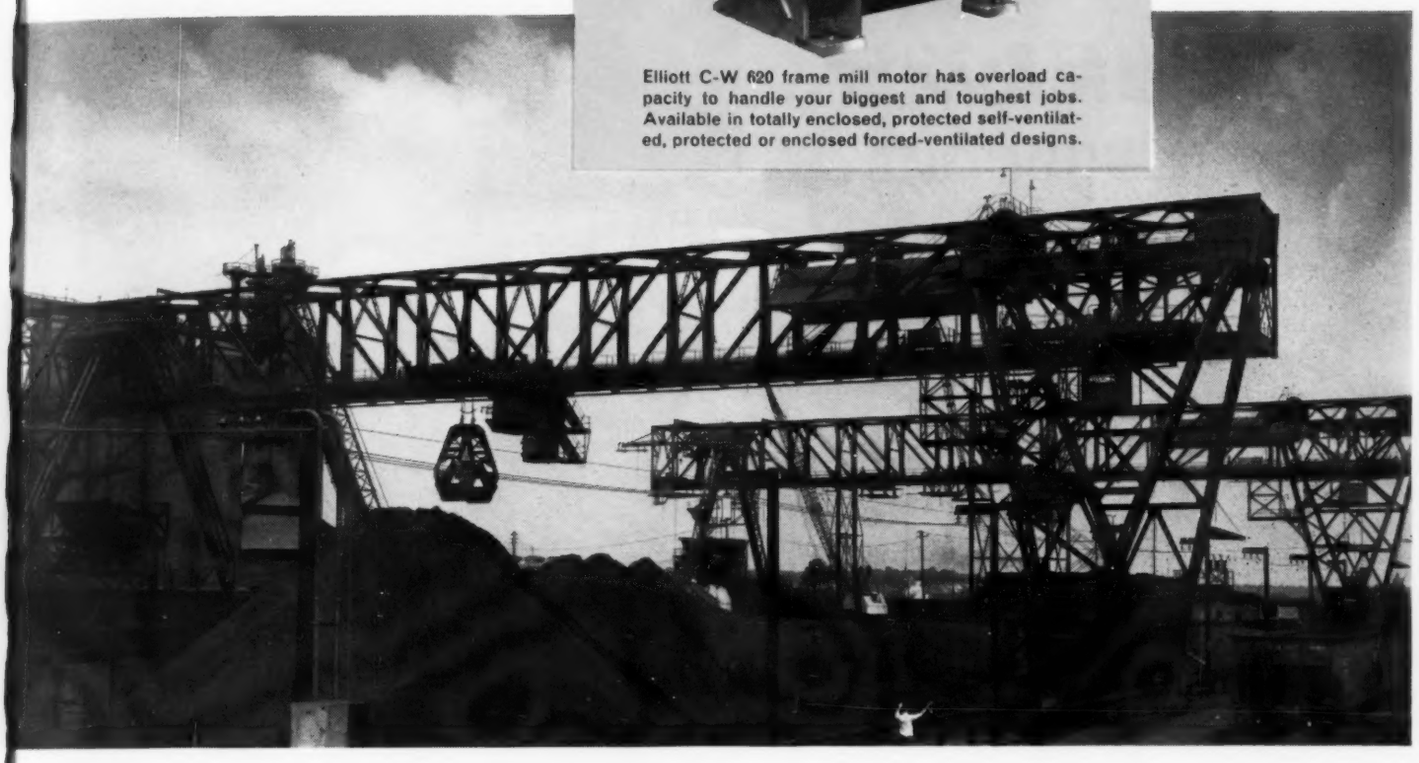
Elliott supplied all a-c and d-c motor drives, 10 to 800 hp, for the above trolley unloader. Use of d-c adjustable-voltage control on the bucket which scoops up a 22½-ton load every 45 seconds and trolley travel which transfers ore from ship to hopper assures smooth, precise control of all bridge movements. Auxiliary d-c mill motors drive the apron hoist, tower travel, rail clamp release and trolley turntable. The large, enclosed structure at the top houses mill motors, control equipment and the five-unit adjustable-voltage motor-generator set—all furnished by Elliott.

ELLIOTT
Company
Crocker-Wheeler Plant
Jeannette, Pennsylvania

to skips...

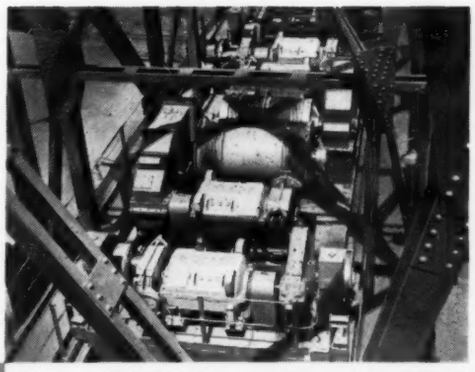


Elliott C-W 620 frame mill motor has overload capacity to handle your biggest and toughest jobs. Available in totally enclosed, protected self-ventilated, protected or enclosed forced-ventilated designs.

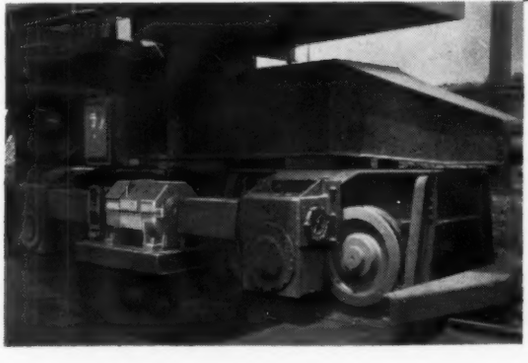


furnish the power to move mountains of ore

Elliott mill motors and motor-generator sets furnish the drives and power for the above gigantic bridges which move mountains of ore from steel mill ore yards to blast furnace hoppers, and subsequently, to skips. The mill motors, operated at double-rated voltage and double speed, are precision controlled from the operator's cab by three master switches and three foot-operated pushbuttons. All adjustable-voltage control equipment, a five-unit adjustable-voltage motor-generator set and all of the electrical drives for both bridges were furnished by Elliott Company.



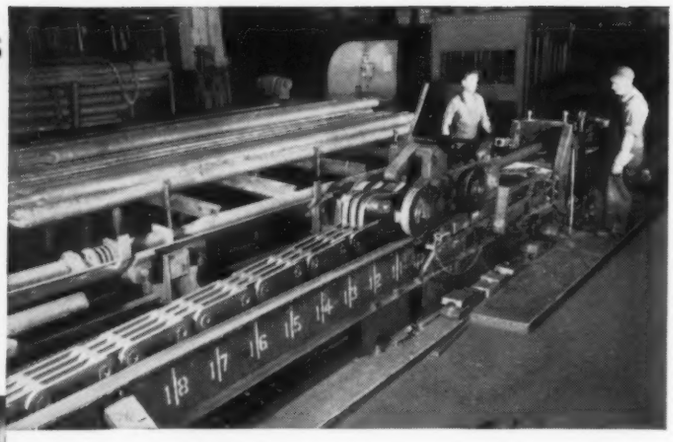
Above: The two Elliott motors nearest the bucket drums are 250-hp hoist engine drives which hoist, open and close the bucket. Identical Elliott motors adjacent to these drive the trolley along its rails.



Left: One of the twin, two-rail trucks which support the bridge pier leg. Each truck is driven by an Elliott 100-hp mill motor. The opposite, or shear leg of the bridge is supported by two sets of single-rail trucks, also driven by 100-hp motors.

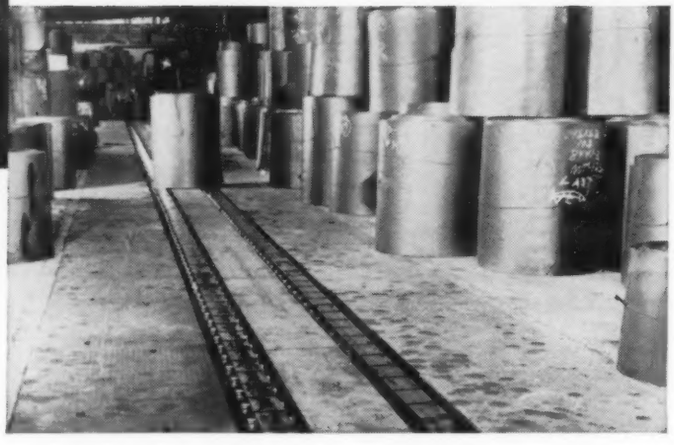
W9-6

The PLUS values of REX® CHAINS



DRAW IT...

...COOL IT



CARRY IT...

more dependably with REX

DRAW IT... For the dependable ruggedness and strength required to transmit the tremendous, steady pull to draw seamless steel tubing, your *plus value* choice is Rex Steel Draw-Bench Chain, made of carefully heat-treated steels for durability. Available in a variety of sizes and steels to suit any application.

COOL IT... To assure the timed, uniform cooling of hot steel tubes, Rex Chabelco Steel Cooling Rock Chain and Attachments provide dependable *plus value* service. Matched chain strands, accurate control of chain pitch, precision-made parts, carefully controlled heat-treatment add up to smooth tube handling ...long service life.

CARRY IT... Rex Steel Coil Conveyor Chain has built-in dependability to assure long life, freedom from breakdowns in this vital service. Special heavy-duty, anti-friction roller chain supplies the smooth-traveling ride for coiled strip or sheet. Rugged platforms mounted on chain attachments provide steady, level carrying surface.

DEPENDABLE SERVICE and chains, too, for coiled wire conveyors, catching and feeding tables, continuous sheet conveyors and annealing ovens, and power transmission equipment. If you're looking for more dependable *plus value* equipment in these operations, why not write CHAIN Belt Company, 4693 W. Greenfield Ave., Milwaukee 1, Wis. In Canada, write CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

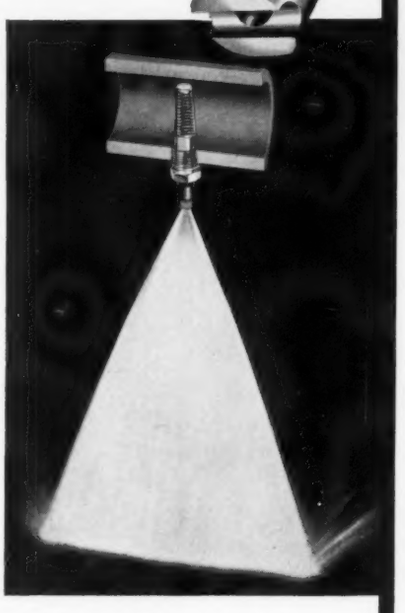
REX®

every installation a complete success

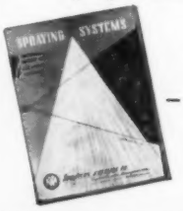
with Spraying Systems Co.

Spray Nozzles

for hot strip spray cooling descaling roll cooling and related operations



● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.



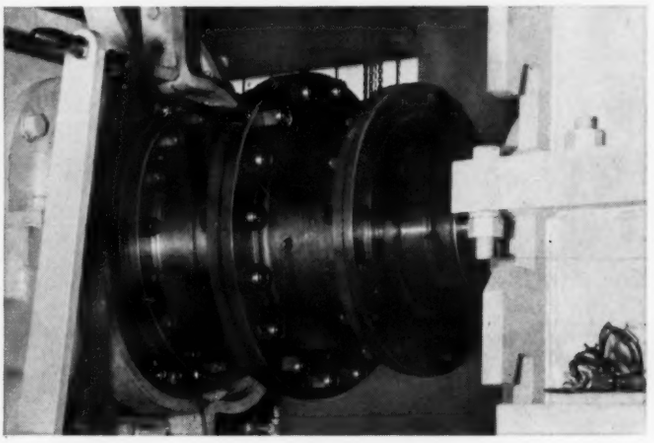
SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.

AT WALDRON...

Specials

ARE STANDARD AND VICE-VERSA



In the picture above is a Waldron #8 Cut-Out Coupling. It couples the power to a shearing machine, which takes mild steel strip from coil, straightens it and cuts it to lengths between 3' and 24' at the rate of 1250 feet per minute.

This is a Waldron "special" because it was developed for a particular application. Waldron engineers put a lot of know-how into producing this unit, but with their knowledge acquired through years of experience in dealing with many similar power transmission problems, it became a simple task.

On the other hand, "standard" couplings receive so much attention in production, that they run as if specially designed for the application. Waldron believes that the coupling is as important as the driver and the driven and so should receive the same fine forgings, machining and assembly as the equipment it couples.

If you are in the market for couplings, either specials or standards, speak to the engineers at Waldron. In both cases you will be assured of the highest quality possible.

MR

JOHN **WALDRON** CORPORATION
Subsidiary of Midland-Ross Corporation
NEW BRUNSWICK, NEW JERSEY

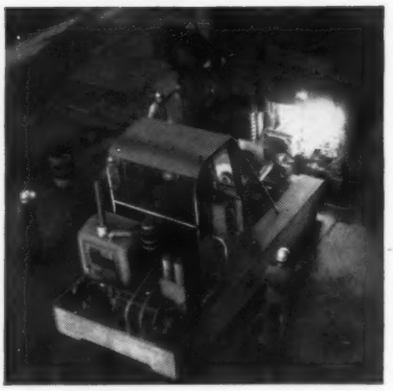
At Lukens Steel, massive ingots are heated for rolling in Salem-Brosius pit-type ingot heating furnaces.

When Lukens Steel expanded it specified Salem Soaking Pits

At Lukens Steel Company of Coatesville, Pa., famed maker of carbon and alloy steel plate and plate products, Salem-Brosius recently completed 12 of the largest soaking-pit furnaces ever designed and constructed. The pits are of the 2-burner, single-end top-fired type, fitted with needle-type metallic recuperators and capable of placing 200 tons of steel under cover per pit.

When asked for an opinion of the soaking-pits, one Lukens operating official said, "If we didn't think that Salem-Brosius pits were best for our purposes, we wouldn't have ordered them. After all, our expansion program calls for the most up-to-date and efficient equipment we can obtain."

Reports like this are not unusual . . . not only concerning soaking-pits, but all other Salem-Brosius heating and heat-treating furnaces. Salem-Brosius engineers are well known for their ability to design furnaces for maximum high-quality output at minimum operating cost. If your plans call for replacing old furnaces or adding new facilities, why not ask us to bid? There will be no obligation.



New Salem-Brosius auto-floor-type charging machine making alloy additions to the electric furnace at Lukens. Salem-Brosius' heavy mechanical equipment matches the quality of its furnaces.

SALEM-BROSIUS, INC.

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Salem Engineering Limited, Toronto, Ontario • Salem Engineering Co., Ltd., London & Milford, England • Salem-Brosius, S.A., Luxembourg • Salem-Brosius, S.A., Paris, France • Alloy Manufacturing Corp., Pittsburgh, Pennsylvania • R. H. Freitag Manufacturing Div., Akron, Ohio • General Ionics Corp., Pittsburgh, Pennsylvania.

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IN METALWORKING: Huge industrial cranes with P&H Electronic "Stepless" Control are used to handle the largest metalworking shop loads with ultra-fast speed, yet with damage-eliminating gentleness. Where duty cycles permit, smaller, moderately priced P&H cranes handle a host of lifting jobs with plenty of muscle, but low investment.

All the mechanical and electrical parts for both big and small P&H cranes are made by and warranted by P&H. We promise undivided responsibility — not a service "run-around". When we sell it, we service it — and our interest in your crane stays active as long as it is on your runway!

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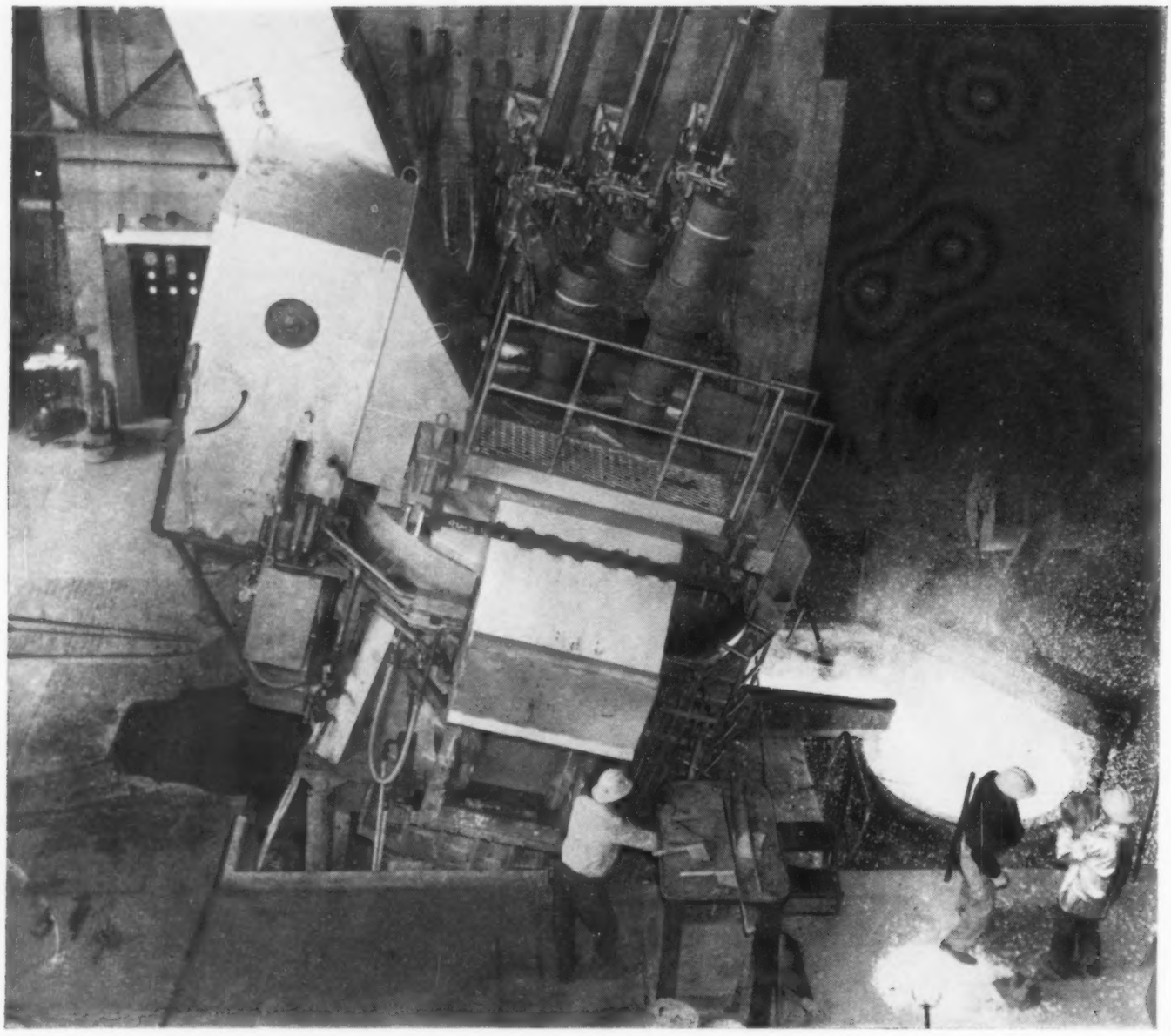

RUGGEDNESS...

A MAJOR FACTOR IN THE LOW MAINTENANCE AND HIGH AVAILABILITY OF LECTROMELT FURNACES

When you're selecting an electric furnace, compare design details and you'll note the heavier, sturdier construction that Lectromelt provides. This pays off for you in *service*—Lectromelt furnaces enjoy a world-wide reputation for high availability and low maintenance.

Lectromelt is the world's most experienced builder of electric furnaces. Whether your needs are for 200-pound or 200-ton capacities, it will pay you to get Lectromelt's recommendations when planning additions or replacements. Catalog 10 contains full information.

Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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Present Situation of Japanese Steel Industry

by Kichiro Saigo, Manager, New York Office,
Yawata Iron & Steel Co. Ltd., New York, N. Y.

Japan's steel industry, the world's sixth largest producer in 1957, has had a remarkable recovery since its postwar low . . . . under a governmental or semi-governmental organization prior to the end of World War II, it is now entirely free enterprise, and much of its modern equipment and technological progress has come from the United States.

IN 1957 Japan produced 6,800,000 metric tons (7,480,000 net tons) of pig iron and 12,570,000 metric tons (13,800,000 net tons) of crude steel which accounts for approximately 4 per cent of the world total, enabling her steel industry to rank sixth in the world's steel production.

The Japanese iron and steel industry was left paralyzed in the immediate postwar period so that the steel output fell to 500,000 metric tons (550,000 net tons) in 1946. In spite of many difficulties, a remarkable rehabilitation was made with the help of increased raw material imports with aid funds from the United States. Steel production increased rapidly from 1,000,000 metric tons (1,100,000 net tons) in 1947 to 4,800,000 metric tons (5,280,000 net tons) in 1950, exceeded the prewar level in 1952, and finally overtook the wartime peak in 1953. Ever since, production has continued to increase at a steady pace.

Table I shows how iron and steel production has increased in Japan.

There are three characteristic differences in the present Japanese steel industry compared with the prewar period. A governmental or semi-governmental enterprise, Japan Iron and Steel Co., used to hold a leading position before the war while at present the industry consists of entirely free enterprises. It was the main task of the prewar steel industry to meet the home requirements only while an importance is now attached to exports of iron and steel products to help develop the Japanese economy besides covering the home requirements. The industry is more dependent for the supply of raw materials on the United States who has taken the place of China, the prewar traditional supplier. In other words, of the iron ore imports, most come from southeastern Asia with some 15 per cent from North America including Canada, whereas before the war one-third came from China and the rest from the countries in south eastern Asia. Of the coking coal imports, more than 80 per cent now comes from the United States whereas before the war most came from China. The United States is also supplying 80 per cent of the scrap imports the same as before the war.

Thus the present Japanese steel industry holds closer relations with the United States not only for the supply of raw materials but for the improvement of productivity, advancement in technology, and also for the capital of the industry. Much reliance is placed on the

TABLE I
Development of Iron and Steel Production

Year	Pig iron		Crude steel		Ordinary rolled steel	
	Metric tons 1000	Net tons 1000	Metric tons 1000	Net tons 1000	Metric tons 1000	Net tons 1000
1951	3,127	3,450	6,502	7,170	4,739	5,200
1952	3,474	3,830	6,988	7,690	4,825	5,300
1953	4,518	4,980	7,662	8,420	5,338	5,850
1954	4,608	5,080	7,750	8,550	5,472	6,010
1955	5,217	5,750	9,408	10,400	6,810	7,500
1956	5,987	6,600	11,106	12,200	8,121	8,920
1957	6,815	7,500	12,570	13,800	9,265	10,200

United States' co-operation, which has an important bearing on the future of the industry.

TREND AND PROSPECTS OF STEEL REQUIREMENTS

For a sound development of the Japanese economy, further expansion of the steel industry is needed to cover the increasing requirements of home industries, especially of the heavy and chemical industries which are tending to have a greater importance in the industrial structure of Japan, as well as to meet the overseas requirements.

The shipbuilding industry in Japan has had a remarkable development since 1956 with increasing orders from oversea countries. The gross tonnage of ships launched from Japanese shipbuilding yards was the highest in the world in 1956. The shipbuilding tonnage in 1957 increased further, tripling that of 1955. Finished steel delivered to this branch in 1957 accounted for 15 per cent of the total shipments. The steel industry will have to cover the requirements arising from the high level of shipbuilding activities and for exports in addition to those for the expansion of the Japanese bottoms which are still below the prewar level.

The mechanical engineering industry has also made a rapid growth since 1956 along with the progess of the expansion programs in the various industries, taking 14 per cent of the Japanese finished steel shipments. Further development is expected of the industry which has good prospects in both home and oversea markets. Construction engineering has been steadily developing, and building work by contractor only accounted for 7 per cent of the finished steel shipments in Japan. However, if such construction and engineering work as carried on within the various industries is taken into account, the total construction is estimated to take a considerable portion of Japanese steel. A continued growth is expected of this sector.

In Japan the proportion of steel deliveries going into consumer goods is estimated to be about 25 per cent, being considerably lower than the United States and European countries where the proportion is respectively 45 and 33 per cent. However, automobile and electrical appliances for household and office use are faced with an increasing home demand, and canned food is rapidly being popularized. The steel requirements from the sector are certain to increase as the living standard of the nation goes up. Table II shows past shipments of ordinary rolled steel by-products.

Apparent consumption of steel per capita in Japan was 111 kg (245 lb) in 1956 and is still far behind the United States where annual consumption per head is around 600 kg (1320 lb) and western European countries where it is in the region of 200 to 450 kg (440 to 990 lb). There is a potential for a considerable increase in Japanese steel requirements.

In common with the trend on the world steel market, requirements for flat rolled steel products in Japan has increased greatly along with the development of her shipbuilding and mechanical engineering. The flat products have always taken 50 per cent of the home deliveries of finished steel and also made a substantial contribution to the increase of iron and steel exports. Table III lists iron and steel exports by geographical area.

RATIONALIZATION PROGRAM OF THE IRON AND STEEL INDUSTRY

While stressing operating as many facilities as possible in the immediate postwar period because of its low steel production, the industry was behind those of other countries in starting modernization of equipment. It was not until 1956 that the first rationalization program started at the cost of $300,000,000, laying emphasis on replacement of rolling facilities worn-out by overwork during and before the war. The main equipment installed under the program is as follows: four reversible cold strip mills, two continuous cold strip mills, a continuous hot strip mill, a continuous wire rod mill, an electric welding pipe mill, a Fretzmoon pipe mill, two con-

TABLE II
Shipments of Ordinary Rolled Steel by Product

	1951			1952			1953			1954			1955			1956			1957		
	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent	Metric tons 1000	Net tons 1000	Per cent
Rails	182	200	3.9	254	280	5.0	289	318	5.3	271	298	4.8	334	368	4.7	348	383	4.2	408	449	4.4
Shapes	475	523	10.1	436	480	8.6	598	658	11	527	580	9.4	665	731	9.4	924	1020	11.2	1114	1220	12.1
Bars	915	1010	19.4	1000	1100	19.8	1028	1130	19	1220	1340	21.7	1372	1510	19.5	1497	1640	18.2	1689	1860	18.4
Wire rod	492	541	10.4	459	505	9.1	493	542	9.1	565	621	10.1	717	789	10.2	757	830	9.2	733	808	8.0
Steel pipe	295	325	6.2	339	373	6.7	435	488	8.0	410	451	7.3	482	530	6.8	596	658	7.2	569	625	6.2
Tire	26	28.6	0.6	20	22	0.4	25	27.5	0.5	35	38.5	0.6	69	760	1.0	74	81.5	0.9	83	91.3	0.9
Hoop	114	125	2.5	109	120	2.2	163	179	3.0	121	133	2.2	126	138	1.8	130	143	1.6	161	178	1.8
Plates	1180	1300	25	1443	1580	28.5	1413	1550	26.1	1126	1240	20	1744	1920	24.8	1229	1350	27.1	2655	2930	28.9
Sheets	926	1020	19.4	859	945	17.0	796	874	14.7	1127	1240	20	1290	1420	18.3	1342	1480	16.3	1389	1530	15.1
Electrical sheets	44	48.5	0.9	39	43	0.8	68	74.8	1.2	67	73.8	1.2	58	62.8	0.8	99	109	1.2	142	156	1.6
Tin plates	76	83.8	1.6	97	107	1.9	111	121	2.1	149	164	2.7	187	205	2.7	243	267	2.9	241	265	2.6
Total flat rolled steel	2333	2570	49.4	2547	2800	50.4	2551	2800	47.1	2590	2850	46.1	3405	3750	48.4	4043	4450	49.1	4588	5040	50
Grand total	4719	5200	100	5055	5550	100	5419	5950	100	5617	6190	100	7044	7750	100	8239	9080	100	9184	10,100	100

TABLE III
Exports of Iron and Steel from Japan by Geographical Area

	Asia		Europe		North America		South America		Africa		Oceania		Total	
	Metric tons	Net tons	Metric tons	Net tons	Metric tons	Net tons	Metric tons	Net tons	Metric tons	Net tons	Metric tons	Net tons	Metric tons	Net tons
	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1951	318	350	47	51.8	130	143	231	254	43	47.3	223	245	992	1100
1952	616	678	468	515	235	259	94	103	86	94.8	113	124	1612	1770
1953	445	490	146	161	99	109	127	140	20	22	3	3.3	840	925
1954	597	658	26	28.6	54	59.4	472	520	24	26.4	20	22	1193	1310
1955	910	1000	89	98	184	203	598	659	99	109	144	158	2024	2220
1956	690	760	96	106	160	176	298	328	34	37.4	29	32	1307	1435
1957	780	859	49	54	108	119	28	30.8	52	57.2	2	2.2	1019	1120

tinuous galvanizing lines, an electrolytic tinning line, a 4-high plate mill. In addition, renovation of ancillary equipment was made under the program.

On the other hand, technical co-operation mainly with American steel companies and an invitation to American technical experts for consultation have made possible an introduction of new techniques and an improvement in operation at every manufacturing stage. The technical advance thus achieved, together with the effects of the rationalization program, resulted in a marked improvement in productivity, yield of production and heat and materials consumption.

In the period from 1950 to 1957, labor productivity doubled. The national average consumption of materials and heat showed a good improvement in the same period. For example, coke ratio decreased from 900 kg to 715 kg (1980 to 1570 lb) heat consumption per ton of sound ingot from 1,869,000 to 995,000 kilogram-calories (7,410,000 to 3,600,000 Btu per net ton). The yield of sound ingot has increased from 88.1 to 91 per cent. Table IV shows the changes in the industry's productivity since 1950. Table V gives data on raw materials and heat consumption.

However, the continued growth of the national economy and the resultant increase in steel requirements called for a further expansion of iron and steel production capacity so that the second rationalization program has started since 1956 with an estimated cost of $1,500,000,000.

The aim of the program is to increase the production capacity not only by expansion and renovation of the existing equipment but by constructing a new integrated plant of modern design at new sites, to keep pace with the growing Japanese economy. Thus, in 1962 12,500,000 metric tons (13,800,000 net tons) of pig iron and 20,000,000 metric tons (22,000,000 net tons) of crude steel will have to be produced because the home requirements for finished steel is estimated to increase at an annual rate of 8.2 per cent and export requirements at 10 per cent.

From the viewpoint of the world-wide shortage of steel scrap, 10 blast furnaces, including ones of modern type with daily capacities of 1200 to 1500 metric tons (1320 to 1650 net tons) and 15 converters (of which four have been in operation), are to be installed by 1962. The program also includes installation of five blooming mills, four continuous hot strip mills, a continuous cold

TABLE IV
Productivity of Iron and Steel Industry

	Crude steel production			Production per man		Productivity (1950 = 100 per cents)	Man-hours			
							Blast furnace pig iron		Open hearth steel ingot	
	Metric tons	Net tons	Employees	Metric tons	net ton		Per metric ton	Per net ton	Per metric ton	Per net ton
	1000	1000								
1950	4839	5310	165,000	29	31.9	100				
1951	6502	7150	192,000	34	37.4	117	5.63	5.12	9.20	8.38
1952	6988	7690	188,000	37	40.7	129	6.03	5.49	9.32	8.50
1953	7662	8410	199,000	38	41.8	131	4.93	4.48	8.32	7.58
1954	7750	8510	188,000	41	45.1	141	4.85	4.41	7.87	7.15
1955	9408	10,400	185,000	51	56.1	176	4.40	4.00	6.94	6.31
1956	11,106	12,200	201,000	55	60.6	189	4.06	3.70	6.42	5.85
1957	12,570	13,800	213,000	59	65.0	203	3.75	3.41	6.30	5.73

TABLE V
Data on Open Hearth Operation

	Iron ore		Coke		Heat		Hourly output of sound ingot		Yield of sound ingot, per cent
	Net tons per net ton of blast furnace pig iron	Kg per metric ton of blast furnace pig iron	Lb per net ton of blast furnace pig iron	Kg per metric ton of blast furnace pig iron	Btu per net ton of sound ingot	Kg-cal per metric ton of sound ingot	Net tons	Metric tons	
1951	1.617	1617	1830	915	6,390,000	1,771,000	8.30	7.53	88.9
1952	1.593	1593	1776	883	5,800,000	1,609,000	9.65	8.78	89.2
1953	1.630	1630	1676	838	4,890,000	1,357,000	11.2	10.19	90.3
1954	1.591	1591	1502	751	4,160,000	1,157,000	12.0	10.93	91.1
1955	1.574	1574	1422	711	3,800,000	1,051,000	12.9	11.69	91.8
1956	1.573	1573	1454	727	3,700,000	1,025,000	13.5	12.23	90.9
1957	1.543	1543	1430	715	3,600,000	995,000	14.4	13.12	91.2

TABLE VI

Main Equipment under the First and Second Rationalization Programs

Company	Works	Rationalization program	Source of fund	New equipment and description	Manufacturer of equipment	Date of completion
Yawata Iron & Steel Co.	Tobata	1		A continuous cold strip mill, 360,000 metric tons per yr (395,000 net tons), 4-high 5-stand, roll width 42 in, rolling speed 4000 fpm	Mesta (U.S.A.)	April, 1954
	Tobata	1		A Sendzimir continuous galvanizing line. 36-in. wide, galvanizing speed 250 fpm	Aetna (U.S.A.)	May, 1953
	Tobata	1		A ferrostan electric tinning line, 96,000 metric tons (106,000 net tons) per yr, tinning speed 800 fpm	Wean (U.S.A.)	April, 1955
	Yawata	1	World Bank	A 160-in., 4-high plate mill, 420,000 metric tons (462,000 net tons) per yr	U.E. (U.S.A.)	October, 1957
	Yawata	2		A blooming mill 1,200,000 metric tons (1,320,000 net tons), per yr, roll width 116 in., roll diam 48 in.	Sack (Germany)	August, 1958
	Yawata	2	Export-Import Bank of Washington	Expansion of electrical sheet mills		
	Tobata	2	World Bank	Two 1500-ton blast furnaces		1959–60
	Yawata	2	World Bank	Three 60-ton oxygen converters	Demag (Germany)	1959–60
	Yawata	2	World Bank	A 2-high reversing mill, 1,800,000 metric tons (1,980,000 net tons) per yr, roll width 116 in., roll diam 48 in.	Sack (Germany)	April, 1960
	Yawata	2	Export-Import Bank of Washington	Expansion of a hot strip mill to 840,000 metric tons (925,000 net tons) per yr		
	Yawata	2	Export-Import Bank of Washington	A continuous cold strip mill, 360,000 metric tons (396,000 net tons) per yr, 4-high, 4-stand, roll width 56 in., rolling speed 3000 fpm	Mesta (U.S.A.)	September, 1958
	Yawata	2	Export-Import Bank of Washington	A reversing cold strip mill, 60,000 metric tons (66,000 net tons) per yr, roll width 80 in., rolling speed 1600 fpm	U.E. (U.S.A.)	May, 1957
	Yawata	2	Export-Import Bank of Washington	A semi-continuous hot strip mill, 600,000 metric tons (660,000 net tons) per yr, 4-high, 6-stand, roll width 80 in., rolling speed 2400 fpm	U.E. (U.S.A.) and Mesta (U.S.A.)	October, 1958
Fuji Iron & Steel Co.	Hirohata	1		A continuous cold strip mill, 480,000 metric tons (528,000 net tons) per yr, 4-high, 5-stand, roll width 58 in., rolling speed 4000 fpm	U.E. (U.S.A.)	May, 1958
	Hirohata	1		A continuous galvanizing line, coil width 20 to 48 in., galvanizing speed 220 fpm	Aetna (U.S.A.)	November, 1954
	Muroran	2		A continuous hot strip mill, 600,000 metric tons (660,000 net tons) per yr, roll width 56 in., rolling speed 2200 fpm	U.E. (U.S.A.)	September, 1958
	Hirohata	2	World Bank	A 1500-ton blast furnace		December, 1959
	Hirohata	2	World Bank	Two 50-ton oxygen converters	Undecided	September, 1959
	Hirohata	2	World Bank	A blooming mill, 1,800,000 metric tons (1,980,000 net tons) per yr	Undecided	December, 1959
	Hirohata	2		A plate mill, 480,000 metric tons (528,000 net tons) per yr 4-high, 5-stand, roll width 160 in.	U.E. (U.S.A.)	1958–59
	Hirohata	2		A reversing cold strip mill 960,000 metric tons (105,000 net tons) per yr, roll width 80 in.	U.E. (U.S.A.)	March, 1959
Nippon Kohan K.K.	Kawasaki	1		A continuous butt-weld pipe mill, 120,000 metric tons (132,000 net tons) per yr, rolling speed 13 to 4.6 fpm	Aetna (U.S.A.)	July, 1954
	Kawasaki	1	World Bank	A medium diameter pipe mill, 120,000 metric tons (132,000 net tons) per yr	Aetna (U.S.A.)	November, 1957
	Mizunoe	2	World Bank	Two 60-ton oxygen converters	Demag (Germany)	September, 1959
	Mizunoe	2	World Bank	A blooming mill, 1,500,000 metric tons (1,650,000 net tons), per yr roll width 114 in., roll diam 47 in.	Blaw-Knox (U.S.A.)	September, 1959
	Mizunoe	2	World Bank	A continuous hot strip mill, 600,000 metric tons (660,000 net tons) per yr, roll width 68 in.	Undecided	September, 1959
	Mizunoe	2	World Bank	A reversing cold strip mill, 80,000 metric tons (88,000 net tons) per yr, roll width 66 in.	Undecided	September, 1956
Kawasaki Steel Corp.	Chiba	1		A 600-ton blast furnace		January, 1953
	Chiba	1		Three 100-ton open hearths		March, 1954
	Chiba	1		A blooming mill, 1,300,000 metric tons (1,430,000 net tons) per yr, roll width 115 in., roll diam 43 in.	U.E. (U.S.A.)	September, 1954
	Chiba	1	World Bank	A semi-continuous hot strip mill, 400,000 metric tons (440,000 net tons) per yr, 4-high, 5-stand, roll width 56 in., rolling speed 2200 fpm	U.E. (U.S.A.)	July, 1958
	Chiba	1	World Bank	A continuous cold strip mill, 300,000 metric tons (330,000 net tons) per yr, 4-high, 4-stand, roll width 56 in., rolling speed 3190 fpm	U.E. (U.S.A.)	July, 1958

TABLE VI (continued)

Sumitomo Metal Industries, Ltd.	Wakayama Wakayama	2 2	World Bank World Bank	A 1000-ton blast furnace A blooming mill, 1,200,000 metric tons (1,320,000 net tons) per yr, roll width 118 in., roll diam 48 in.	Sack (Germany)	September, 1961 December, 1959
Kobe Steel Works	Nadahama	2	World Bank	A 600-ton blast furnace		December, 1958
Nichia Steel Works	Kure	1		A continuous hoop mill, roll width 26 in., rolling speed 230 fpm	Louis (U.S.A.)	June, 1953
Toyo Kohan Co.	Kudamatsu		Export-Import Bank of Washington	A continuous cold strip mill, 300,000 metric tons (330,000 net tons) per yr, roll width 53 in., rolling speed 4500 fpm	Mesta (U.S.A.)	March, 1959

strip mill, seven reversing cold strip mills, seven Sendzimir cold strip mills, and a 4-high plate mill. Table VI shows some of the main equipment installed and scheduled. Figure 1, a map of Japan, shows its steelmaking facilities.

Since 1955 loans totaling $144,200,000 have been granted from the International Bank for Reconstruction and Development and the Export-Import Bank of Washington to the main Japanese steel producers and are playing an important role in execution of the present program. Modern iron and steel equipment bought from the United States represents 85 per cent of the total expense of $161,000,000 spent for the import of production facilities needed under the rationalization programs since 1951.

PRESENT PROBLEMS

Under the influence of the adverse balance in the foreign trade of Japan after the middle of 1957, the growth of the Japanese economy has slowed down with the resultant decrease in steel requirements. Therefore, crude steel production of this year is estimated to be somewhat lower than the 12,000,000-metric ton (13,200,000 net tons) top level. Some difficulty is also found in the financing of the expansion programs due to the tight-money policy of the government. But the iron and steel industry is determined to go ahead with the original plan in the light of the long term growth of national economy.

As one of the moves to bring a speedy recovery from the present recession, efforts are made to increase the exports of primary and secondary products of iron and steel. Exports of iron and steel hold fairly important position in the total economy of Japan, and a considerable proportion of her exports have been shipped to the countries in southeastern Asia. The economic tie with those nations in the form of steel exports and raw materials imports is inevitable to the economy of Japan. In this connection, hopes are entertained of the financial help of the United States to those countries because it will greatly facilitate the economic development of Asia.

Another problem facing the industry is that of raw materials. Both iron ore and coal will have to be imported in greater quantity to feed the equipment expanding under the development program. At present, a rationalization is in process from a broader viewpoint to bring down the cost of imported raw materials. It involves securing of constant coal and iron ore supply from abroad, improvement of ore preparation, lowering of dependence upon scrap imports, and construction of ore carriers.

The scarcity of high coking coal in Japan has led her steel industry to depend upon the imports of American coal, of which the good coking quality and the low ash content have well offset the disadvantage of the long transport distance. Although a modernization program is under way in the coal mining industry toward a mech-

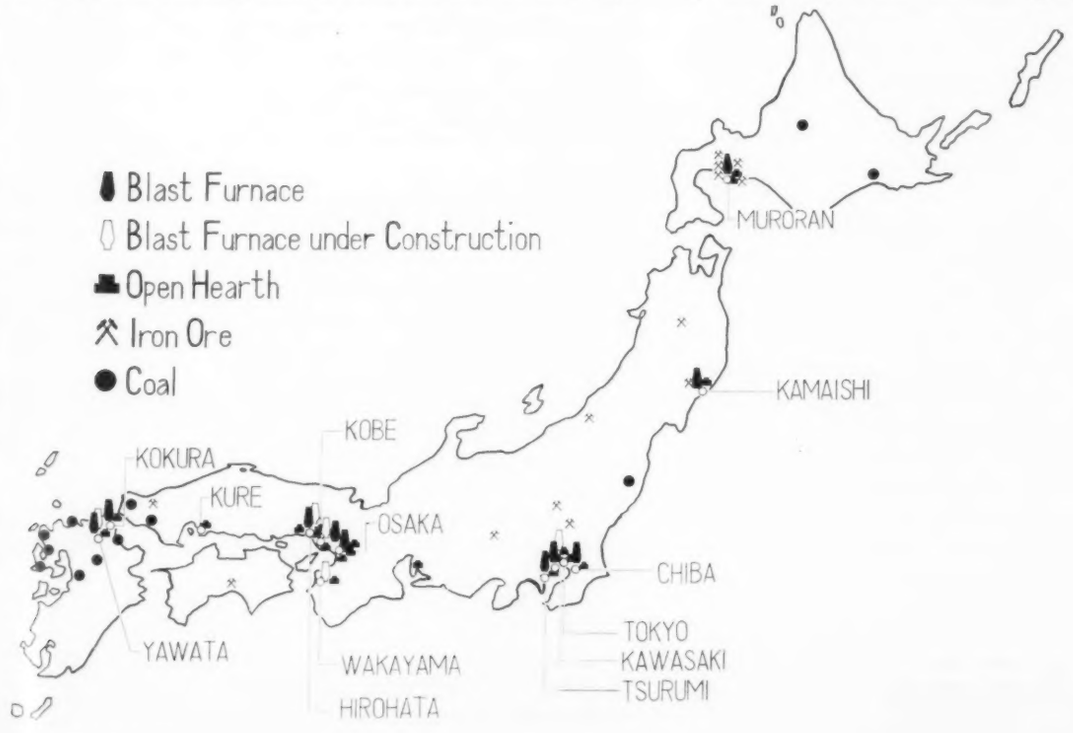


Figure 1 — Steelmaking facilities and iron ore and coal resources of Japan.

anization of mining methods and a wide application of shaft excavation with an aim of producing 60,000,000 metric tons (66,000,000 net tons) of coal in 1962, consumption of imported coal in the steel industry is going to increase. Of 7,000,000 metric tons (7,700,000 net tons) of coking coal consumed by the industry during 1957, 55 per cent were of home and 45 per cent were of foreign origin. The coking coal requirements in 1962 are estimated to be 14,300,000 metric tons (15,800,000 net tons), of which 5,800,000 metric tons (6,400,000 net tons), or 40 per cent, will be available from home resources, while the remaining 8,500,000 metric tons (9,390,000 net tons), or 60 per cent will have to be brought from abroad. The steel industry is now studying the possibility of opening up new sources of coal at Alaska, Saghalien and Australia in co-operation with the countries concerned for the purpose of securing an ample coal supply to meet the increasing requirements. However, the Japanese steel industry will still have to depend on American coal to cover 55 per cent of its estimated import requirements in 1962.

Because it is believed that the supply of American heavy melting scrap will follow a gradual decrease in the future, the Japanese steel industry, like those of European countries, is stressing construction of blast furnaces and converters to increase steel production with less dependence on scrap consumption. The output of open hearth steel is to increase over the next five years from 10,000,000 to 12,000,000 metric tons (11,000,000 to 13,200,000 net tons) while converter steel production will be raised by more than 10 times from 454,000 metric tons to 4,770,000 metric tons (500,000 to 5,250,000 net tons).

Although the proportional rise in scrap requirements will thus be checked, iron ore requirements are to increase in a bigger scale so that ore imports will amount to 16,000,000 metric tons (17,600,000 net tons) in 1962 as compared with 9,000,000 metric tons (9,900,000 net tons) in 1957. One of the undertakings to secure a continued supply of iron ore is the recent drawing-up of an Indo-Japanese joint program for a long term development of iron ore mines at Rourkela. At home, technical progress is being made in the preparation of raw materials such as application of ore bedding, ore sizing and pelletizing in addition to an increased use of iron sand and pyrite cinder, both of which are abundantly found in Japan.

A serious consideration is given to construction of ore carriers and expansion of harbor facilities to handle the growing volume of ore imports with minimum cost. At present, freightage represent about 40 to 70 per cent of the cost of imported ores, and foreign vessels are taking care of about 50 per cent of Japanese ore trade. Expansion of its fleet of ore carriers will not only lower the transport cost but increase the ore shipping by Japanese vessels to the advantage of the Japanese economy. Presently, Japanese ore carriers count only 10 including three launched in 1958, and carried 560,000 metric tons (617,000 net tons), or 8 per cent of the ores imported in 1956. For an effective handling of ore traffic, an additional 44 ore carriers will have to be built by 1962. The government, steel industry and shipbuilding industry are making co-operative arrangements to realize the long range program of building ore carriers at an estimated cost of $160,000,000.

Discussion

PRESENTED BY

W. W. POWELL, Vice President, Mesta Machine Co., Pittsburgh, Pa.

W. J. BROWN, Marketing Technology Service, Gulf Research & Development, Pittsburgh, Pa.

W. W. Powell: Among all the nations, Japanese purchases in the United States rank very high for all commodities including machinery. Our company has had a pleasant relationship with the Japanese steel industry for many years, having built a bar mill for them as early as 1907.

Many people in the United States who have never visited the various steel plants in Japan are unaware of the excellent facilities in use in the Japanese steel industry of today. Consideration of the larger producers will serve to illustrate the scope of their operations. Yawata Iron & Steel Co., the largest steel producer in the Orient at the present time, has 12 blast furnaces, several blooming mills, structural mills, rod mills, plate mills up to 160 in. wide, two hot strip mills, 80 and 43 in. wide, one 42-in. 5-stand tandem cold mill and a 54-in. 4-stand tandem cold mill with skin mills and auxiliary equipment.

Fuji Iron & Steel Co. has three blooming mills, plate mills, structural mills, rod mills, bar mills, an 80-in. hot strip mill and a 56-in. hot strip mill with cold mills.

Nippon Kokan Kabushiki Kaisha are the largest producers of tubes in Japan. In addition to tubes, they produce plates, structurals and bars. Their plate mill is a modern unit, and they are now installing a 68-in. hot strip mill. Much of the above equipment has been supplied by American producers.

W. J. Brown: Paralleling the recovery and expansions of the steel industry, Japan's petroleum industry has also expanded their refining facilities in an effort to keep pace with the increasing demands of their domestic and foreign markets. The Idemitsu Kosan Co., Ltd. has been very active in this rehabilitation program and has done an outstanding job of assisting the steel industry on problems involving lubricants and fuels. Their new 40,000 barrel per day refinery at Tokuyama was constructed two years ago in an effort to keep a constant flow of gasoline and fuels to their ever increasing domestic market.

Basically it was the Japanese, 90,000,000 thrifty, hard working people who put themselves where they are today.

Japanese farmers, probably the best in the world, produce 90 per cent of the nation's rice. Japan's fishermen, the world's greatest, catch more fish than any other people. Its shipyards build more ships.

The chemical industry has tripled its output since the end of the war. Its infant auto industry ranks eighth in production of passenger cars, fifth in trucks and is among the leaders in the manufacture of diesel buses.

Total production of goods and services is 75 per cent above prewar, and over-all industrial production has doubled in a decade.

In the face of shrinking world markets, Japan alone has bravely set its sights on boosting exports, everything from pocket combs to locomotives, to the tune of $3,150,000,000 this year. It probably will not reach that mark, but it will not be for the lack of trying. ▲

New Operational Features On Patricia Blast Furnace at Fairless Works

. . . . the third Fairless blast furnace, a 28-ft hearth diam, 47,355-cu ft unit has several innovations among which are a status-indicating graphic panel installed in the pyrometer room, automatic stove reversing mechanisms that reduce the time required for changing stoves, an automatic charging control system that expedites furnace charging, and individual air proportioning controls that function to admit equal amounts of air through all the tuyeres . . . .

"BASIC CHARACTERISTICS"

by R. H. White,
Superintendent, Blast Furnaces,
Fairless Works,
United States Steel Corp.,
Fairless Hills, Pa.

THE blast furnace dept. at Fairless Works consists of three modern blast furnaces. The first two furnaces, Nancy and Hazel, were built between 1951 and 1953, Nancy, being blown-in on December 11, 1952, and Hazel on June 1, 1953.

The rated production of each of these furnaces was originally 1500 tons of hot metal per day. As operating practices have been perfected, the production rate has risen until the average daily production per furnace is now over 2000 tons. During the months of May, July, and August, 1957, new industry records were set for hot metal production by Hazel furnace. The records that now stand are 70,108 tons of hot metal for one month and 2564 tons of hot metal per day.

The latest addition to the department, Patricia furnace, is expected to exceed these production rates. The 20-tuyere furnace has a hearth diameter of 28 ft, a working volume of 47,355 cu ft, and a working volume to hearth area ratio of 76.9. Although no radical changes in furnace lines were made, several innovations have been incorporated which are expected to increase furnace production.

A graphic panel was installed in the pyrometer room so that operating personnel can tell at a glance the status of the furnace. Automatic stove reversing mechanisms were installed to reduce the time required to change the stoves from "gas to blast" or "blast to gas." The furnace charging control system has been made as automatic as possible thereby allowing more rapid filling of the furnace. Individual air proportioning controls were installed on each tuyere so that an equal amount of air will enter the furnace through all tuyeres. These four changes in design are expected to increase the production rate of hot metal; how much remains to be seen.

"ELECTRICAL CONTROLS"

by W. O. Smith,
Electrical Engineer,
Fairless Works,
United States Steel Corp.,
Fairless Hills, Pa.

FOR some years, there was limited progress in the field of furnace charging control. About three years ago, a furnace and an electrical manufacturer undertook a joint redesign of charging control, not merely by shuffling existing components but by building a completely new system based on what their combined experience told them was required for such a control. The result of their work is the new control for Fairless Works' No. 3 furnace.

The function of the charging control is to charge a furnace as fast as necessary to keep the furnace full and to provide reserve charging capacity for improvements in

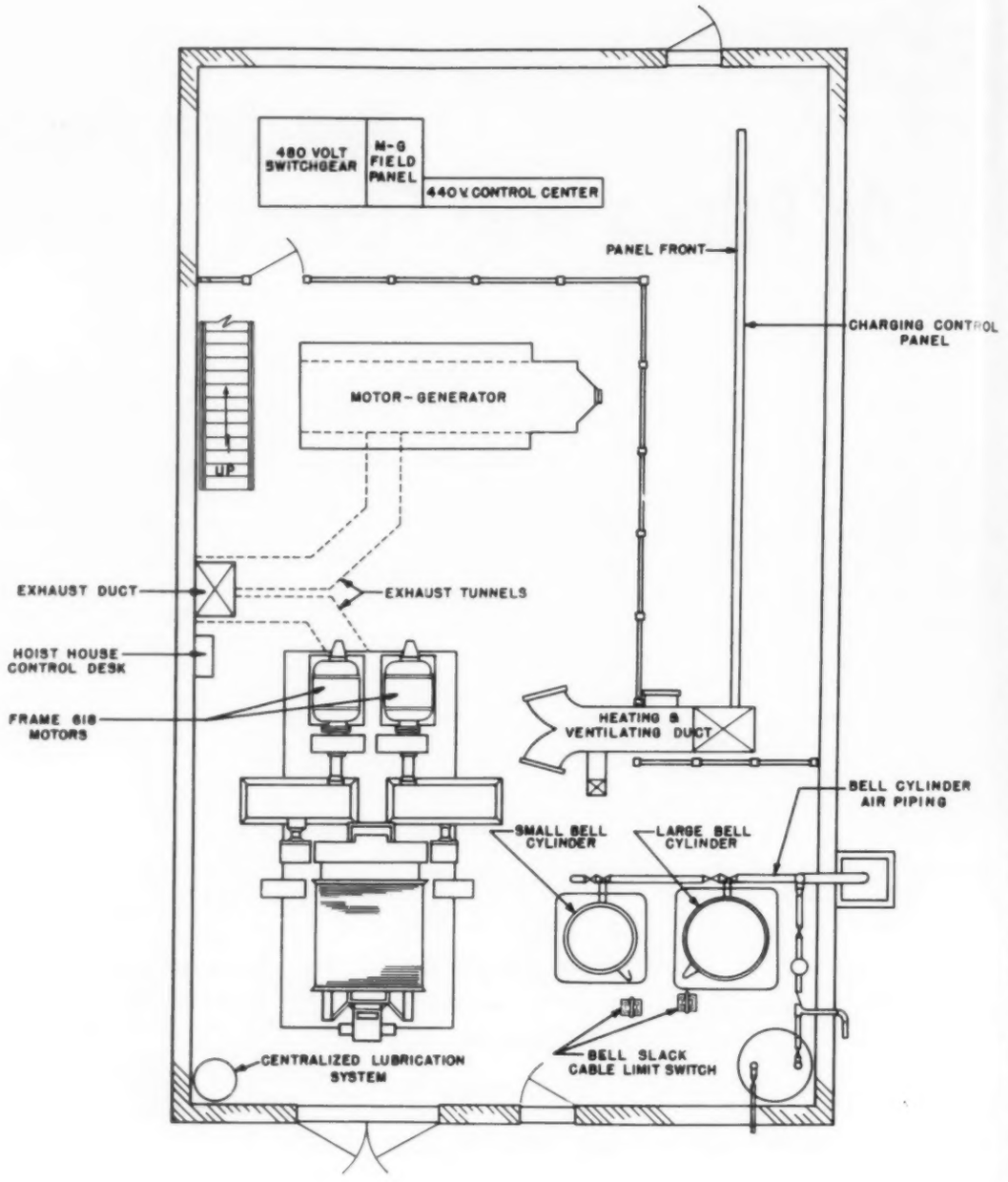


Figure 1 — This is the first floor plan of Fairless Works blast furnace No. 3 hoist house.

operating practice. A corollary objective, keeping the furnace full with as little use of manpower as possible, is receiving ever-increasing attention. The reasons for developing this new charging control are: (1) to provide greater flexibility in choosing charging cycles, (2) to provide more information to operators and maintenance personnel, and (3) to present this information in a form which will be of maximum value to them.

The complete system of charging control includes equipment located in both the hoist house and the stockhouse. The major item in the hoist house is a panel about 35 ft long on which are mounted all of the control devices (relays, meters, voltage regulators, etc.), the power transfer switches required for transferring from the main motor-generator to the spare motor-generator, the equipment for setting the charging cycle, and the indicating and annunciating facilities. Figure 1 shows the location of this panel in the hoist house, and Figure 2 shows a front view of the panel.

One of the big problems around a blast furnace is keeping the electrical equipment clean. For this reason, the hoist house is ventilated with electrostatically cleaned air which flows at the rate of 21,000 cfm. This is sufficient to keep the hoist house under a slight positive pressure. A part of this air is introduced directly into the separate room containing the charging control, the 480-volt switchgear and the 440-volt motor control center.

The charging cycle selection and indication functions are among the most notable features of the charging control. Figure 3 shows the section on the extreme left of the hoist house panel where the equipment is located for setting the charging cycle. There are 18 horizontal rows of selector switches with four switches per row. Each row corresponds to one skip load, so there can be a charging cycle of as many as 18 skips. For each skip, the following four selections are made:

1. Whether or not to dump the large bell.
2. Type of burden (coke, stone or ore).

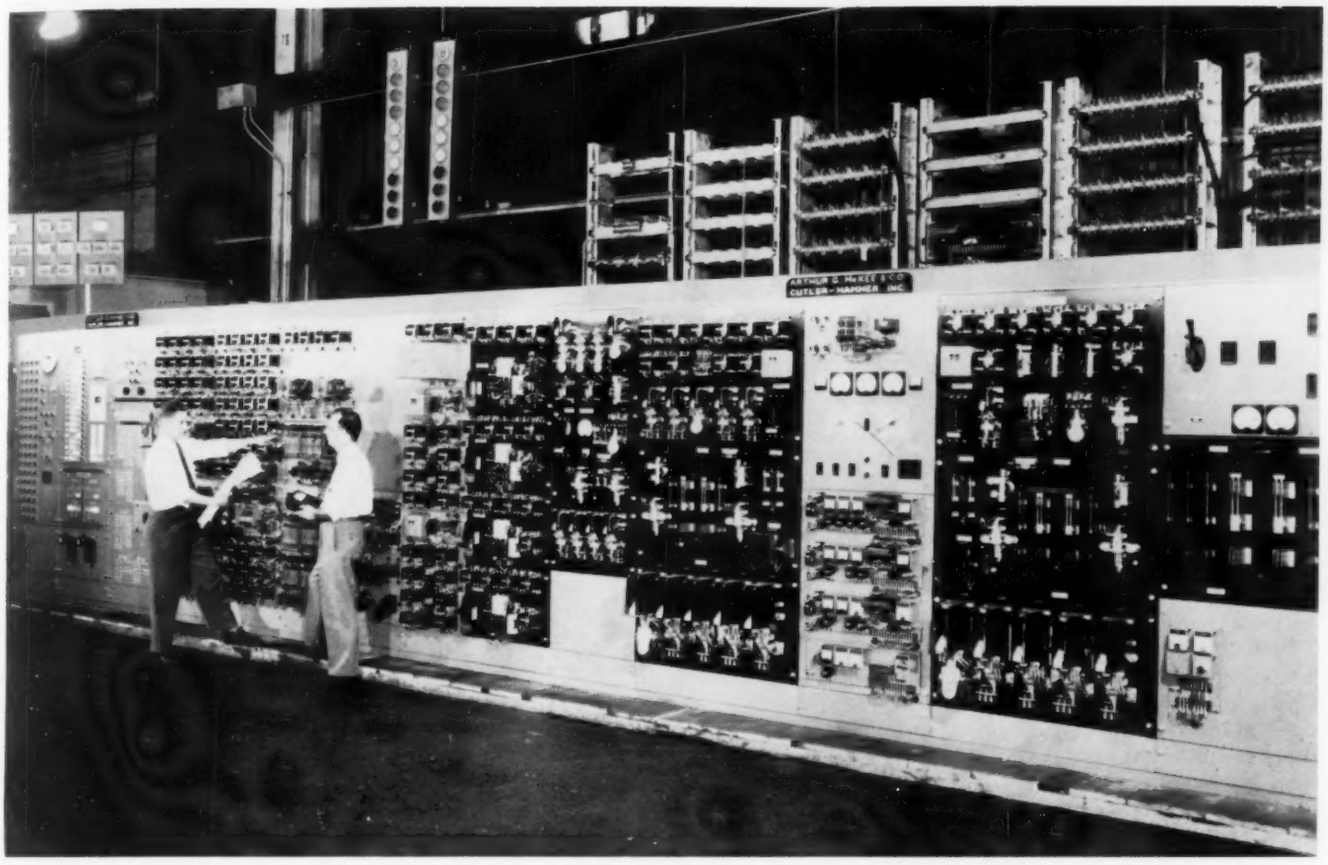


Figure 2 — On this 35-ft long panel in the blast furnace hoist house are mounted the devices of the charging control system.

3. Whether or not to add water.
4. Whether or not to change the distributor rotation angle.

As the first two of the above selections are made, they are automatically registered on an illuminated burden card on the adjacent section of the panel. The windows of the burden card are engraved with the name of the material, and they are colored blue for coke, yellow for stone and brown for ore. The column of lights to the left of the burden card shows after which skips the big bell will be dumped. A column of lamps to the right of the burden card indicates, by a light at the appropriate row, which charge is next in the cycle.

The operation of the skip hoist, large and small bells and distributor are graphically indicated as follows. For each skip hoist there is a group of seven illuminated position indicators, plus an arrow which lights when that skip is moving upward. The position lights show whether the skip is in the pit, the dump position, the slowdown zones or the fast zone. "Stop," "run," "wait" lights show whether the skip is functioning correctly or waiting for some reason such as the small bell hanging open.

The large and small bells each have their own group of symbols which show the bell in one of four phases:

1. Bell closed.
2. Bell in process of opening.
3. Bell open.
4. Bell in process of closing.

Also included in bell indications is a digital lamp which shows the number of loads on the large bell. The distributor is represented by a dial with six illuminated arrows at 60 degree intervals corresponding to the six distributor positions. Only that arrow representing the distributor's actual position lights at one time. A light in the center of the dial comes on if an accurate stop has been made. Lighted targets indicate whether the distributor is running or stopped.

Certain information about coke charging is also shown in the hoist house, and a brief resumé of the coke system at this point may be profitable. Coke charging can be done by weight or by volume. There are three furnace coke bins each for both right and left skips, and filling a hopper can be accomplished from either a single bin or from two bins discharging at once. The charging control will automatically rotate the demand on these bins, regardless of whether one or two bins per side are being used. In addition, there is one nut coke bin per side which, since it by-passes the feeder conveyors and screens, will be used only in unusual circumstances.

The choice between weight and volumetric coke charging is made in the hoist house as is the choice of whether to use one or two bins per side. Both right and left coke systems have the following indications:

1. A zero weight light which indicates that the coke hopper has emptied completely after discharging to the skip.
2. A full weight light which indicates that the load in the hopper corresponds to the setting on the coke scale.
3. A full volume light which, when lighted, shows that the coke hopper has been filled to capacity. The full volume cutoff supervises the coke charging at

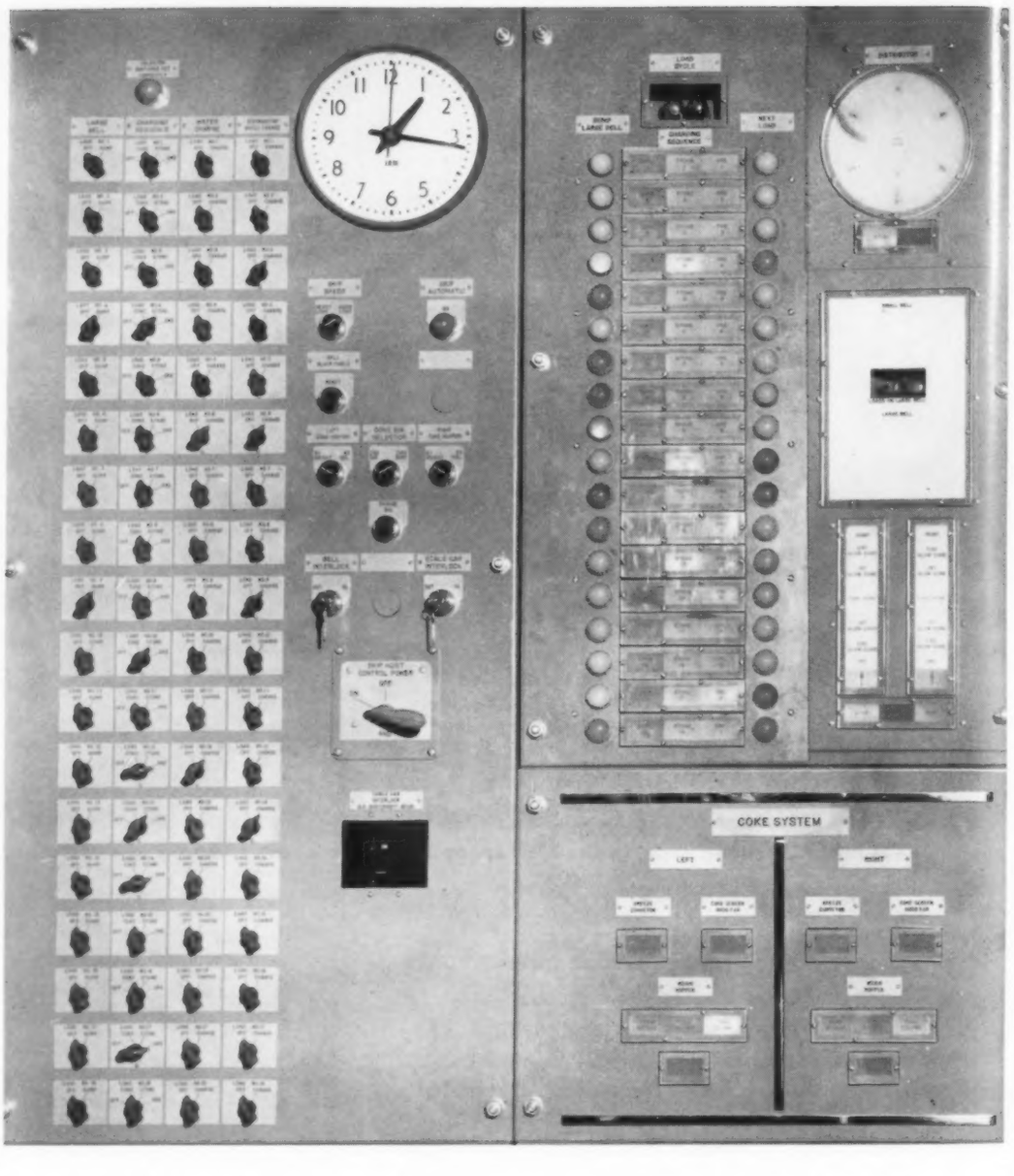


Figure 3 — This portion of the control panel contains the devices for charging selection and indication. Each horizontal row of selector switches controls one skip load as to whether or not to dump the large bell, type of burden, whether or not to add water and whether or not to change the distributor rotation angle. The lights on the panel indicate this charging cycle.

all times so that a charge cannot be chosen whose weight is beyond the volumetric capacity of the coke hopper.

4. Indicator lights which show when the coke breeze conveyor or screen exhaust fan is not running.
5. A light showing when the coke hopper discharge gate hangs open. If this condition occurs, the scale car operator can jog the gate closed from the stockhouse.

In the stockhouse, the operating devices and indications have been arranged on two panels, Figure 4. All the visual indication thus far mentioned as being in the hoist house is repeated here on the indication section of the larger panel.

The scale car operator's panel is a console so located at the edge of the stockhouse platform that the operator can control normal furnace charging from the scale car. To complete the selection of the charging cycle, the operator need only choose nut or furnace coke and turn the coke system on. If the coke hopper gate does not close, he can jog it closed as previously mentioned. A zero weight by-pass button allows the operator to close the hopper gate even though zero weight is not obtained. If a water charge has been set into the cycle, the operator selects the proper quantity. Now the operator can begin charging by turning the skip hoist switch to the "run" position. The coke screening, dumping and hoisting proceed automatically. Ore and stone are delivered by the scale car, and each of these skip loads must be started up by the operator. Lights show water charge, automatic coke charge and the availability of the skip. There are four buttons for charging extra loads without changing the setting of the program. These extra loads, although not displacing any of the loads in the preset cycle, are nevertheless counted, both by the "load cycle" counter and the "loads on large bell" counter. The special function of the extra scrap button is to hold the small bell open during dumping so that the scrap goes directly onto the large bell. A "cancel extra load" button can be used at any time prior to dumping the extra load into the skip. For the convenience of the operator, a space has been provided for clipping notes and instructions to the console. A hand microphone on the console is connected into the blast furnace public address system.

If it becomes necessary to operate the charging system

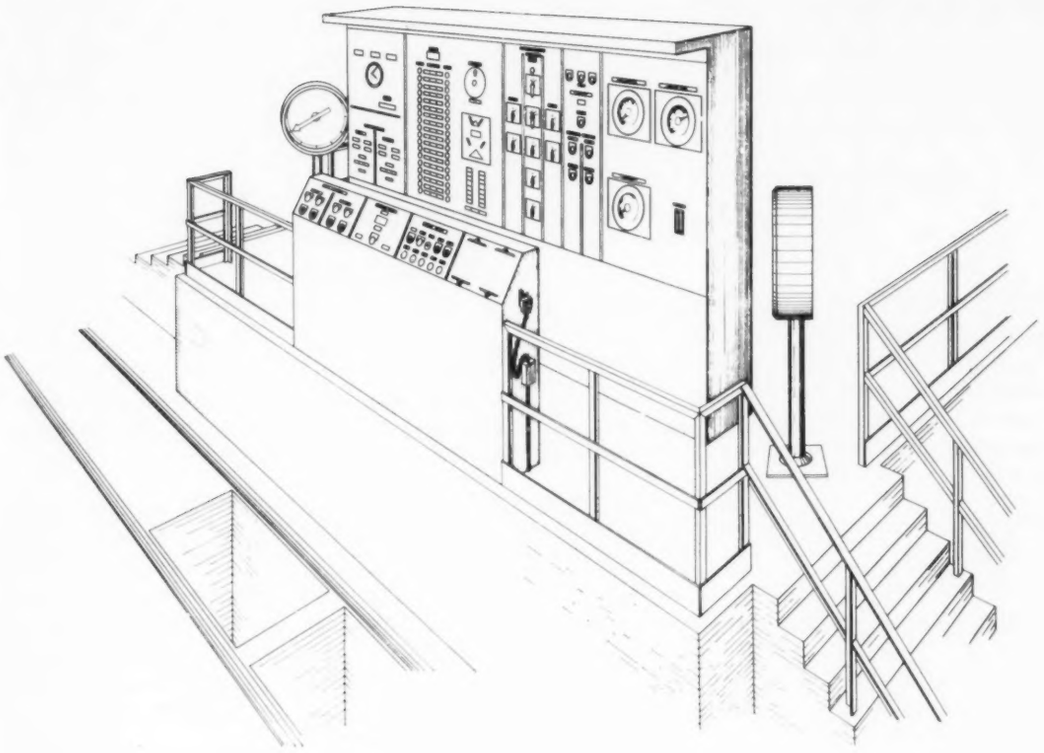


Figure 4 — Some portions of the charging control panel are repeated in the stockhouse.

manually, this is done from the large panel to the rear of the operator's console. The scale car operator must leave the car to operate the manual controls. The flexibility of the system is such that all or part of the coke charging may be left on automatic, if desired, while the rest of the charging is done manually. All essential interlocks maintain their supervision during manual operation, e.g., the large bell cannot be dumped with the stock rods in the furnace. To the right of the manual operating section of the panel, there are combination indicating-recording meters for the stockline and top temperature and a top temperature indicator.

There is one further innovation on this charging control which should be noted. In the hoist house there is a group of indicators and annunciators which monitor the progress of the cycle. The annunciator panel includes memory type fault indicators to supervise protective devices which will operate momentarily on a fault and then reset. In this group are, for example, hoist motor overloads and motor field loss. Tap switch type fault finders are provided to check devices which will open a circuit and remain open until they are reset. An example of these is a governor overtravel. The charging cycle is controlled by five motor-driven program switches. All five are identical in construction, thus simplifying spares stock. Each switch has 18 positions with 24 circuits for each position. Attached to the shaft of each program switch, but electrically separate from the program contactors, is an arm which sweeps across an indicating dial lighting a separate neon light for each position of the program switch. These indicating lights are on the hoist house panel and are labeled to show which operation is underway. If any circuit fails to complete its functions, a glance at the indicator lights tells the maintenance man where to start looking for the trouble. There is a test switch on each of the five program switch drive motors; there is also a reset switch which will return the drive to the position it had before the test switch was used so the charging cycle cannot be inadvertently missequenced by testing procedures.

Following are some of the other outstanding design and construction features of the equipment not heretofore mentioned:

The panels in the stockhouse are dust tight, including gasketed indicating windows.

Color coded wire is used (nine colors). Each wire is identified with a marker tag where it terminates.

The wires are laid in fiber troughs in back of the panels, making individual wires easily accessible.

All control circuits are 110 volts a-c. The control circuits are sectionalized. There are four main groups, each of which has ground detection, and these four groups are further divided into 20 small groups, each group having its own circuit breaker and neon indicating light.

All indicating windows have two lights behind them, rated 3000 hours at normal voltage; they will be operated at 80 per cent voltage.

All a-c relays are the same type and size and all are mounted on the front of the panels. There are about 130 of these relays, and they are identified with abbreviated nameplates.

The hoist house panels are steel except those holding d-c power bus, which are slate. There are no 440-volt circuits on the entire board. For the equipment requiring 440 volts, separate motor control centers are used.

The water tank and electrodes have been eliminated in favor of flow meters for water charge.

Also provided as part of the complete charging control is a control desk in the hoist house which centralizes the devices most often used by the maintenance personnel. Included area skip control master switch, a slack cable backout pushbutton, skip motor brake test buttons, stock rod controls and an emergency stop button.

"INSTRUMENTATION"

by P. E. Hutchings,
Fuel Engineer,
Fairless Works,
United States Steel Corp.,
Fairless Hills, Pa.

THE constant demand for improved instrumentation and control in the hands of the operator, had a considerable influence upon instrument "coverage" for the No. 3 Patricia blast furnace. The engineering groups applied a forward and advanced concept in all respects. The instrumentation is best described by breaking it down into three categories:

1. The graphic panel with its components.
2. Automatic stove changing.
3. Tuyere air proportioning.

The graphic panel, Figure 1, is located in the pyrometer room and presents a pictorial illustration of the operation of the blast furnace and the functions of its many auxiliaries. The controls, the gas and blast mains and the essential valves are diagramatically located and identified, Figure 2, to facilitate supervising the operation of the various equipment. The instruments, in general use throughout the panel, follow the miniature line receiving 3 to 15-psi signals.

The furnace top pressure recorder and bleeder valve control, Figure 3, utilize three pneumatic pressure transmitters which continually measure pressure on three of the four uptakes. Two transmitters, with a range of 0 to 25 psi (A and A on the figure), transmit pneumatic signals to stove platform elevation where they join to a common header and then proceed to the graphic panel for top pressure record. In addition, this same signal feeds the recorder-controller located in the mud gun room for the purpose of furnace bleeder valve sequence operation. It is important to note that *only* two of the three transmitters are available for bleeder valve control with only one unit operating at any one time. The third transmitter of this group has a range of 0 to 100 in. water column and sends pneumatic signals to the graphic panel, and mud gun room for record only.

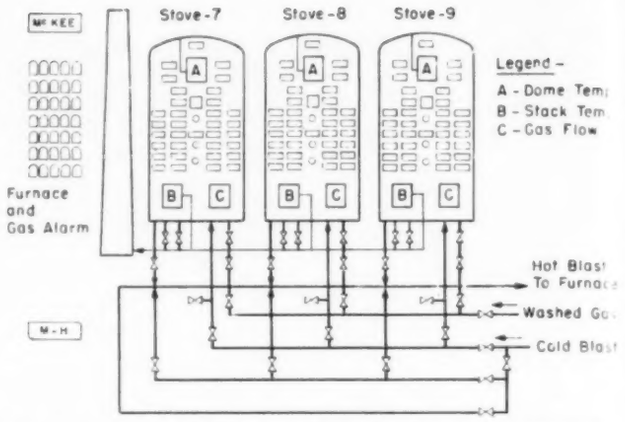
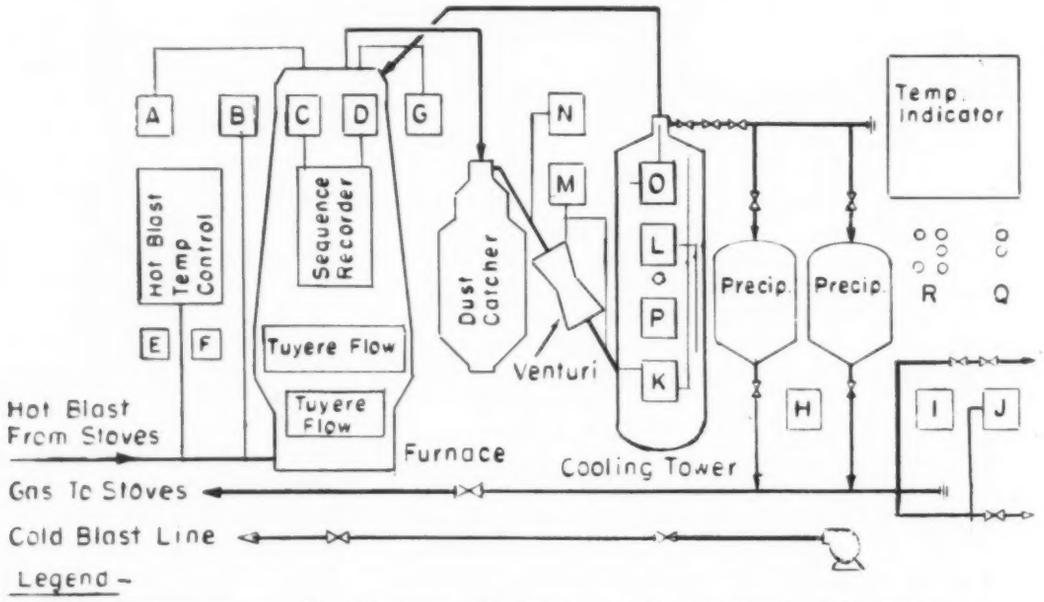


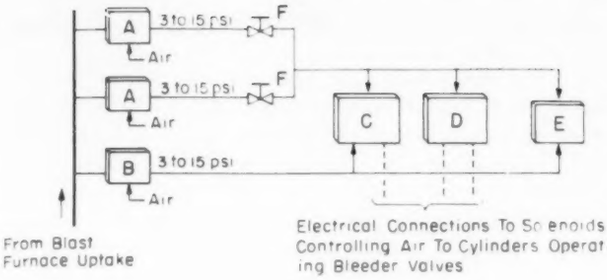
Figure 1 — This graphic panel, located in the pyrometer room, gives a picture of furnace operating conditions.

Control is accomplished by opening the two dirty gas and one washed gas bleeder valves. The washed gas bleeder is set to open first and the two dirty gas bleeders opening next in the sequence. In normal operation only the washed gas bleeder valve will function. This tends to provide reduced maintenance on the two dirty gas bleeder valve seats.

As shown in Figure 4, the blast pressure is measured by transmitter (A) which receives its signal from the bus-

Figure 2 — Schematic of the blast furnace control system.





Legend

A - Pneumatic Pressure Transmitter (0-25 psi) One On Standby.
P - Pneumatic Pressure Transmitter (0-100 IN H_2O)
C - Two-Pen Pressure Recorder In Mud Gun Room Electric Control On One Pen (0-25 psi)
D - Single-Pointer Indicating Pressure Controller In Mud Gun Room Two Electric Control Units
E - Two-Pen Recorder On Graphic Panel
F - Hand Valves

Figure 3 — The furnace top pressure recorder and bleeder valve control utilize three pneumatic transmitters which continually measure pressure on three of the four uptakes.

tle pipe. This signal is converted and recorded on an instrument located in the mud gun room. In addition this same signal is transmitted to the tuyere air control system and to the miniature recorder on the graphic panel.

The stock line level control, Figure 5, incorporates a steel rod and float resting on top of the furnace burden. The counterweighted rod is suspended by a cable which is wound on a reel located in the hoist house. When stock line rods are raised or lowered, the movement is transmitted from the cable reel through a gear reduction unit to the following:

1. A dual transmitting slide wire S1 and S2. The electrical signal from slide wire S1 converts to pneumatic pressure for recording on the graphic panel instrument. Slide wire S2 sends its signal direct to a recording a-c potentiometer located in the stockhouse.
2. A rotary drum contactor switch actuates a vertical blank of signal lights located on the wall of the cast house roof.
3. A selysn transmitter sends a signal to a visualizer receiver in the mud gun room. This unit is the most sensitive and will readily indicate the slightest stock movement.

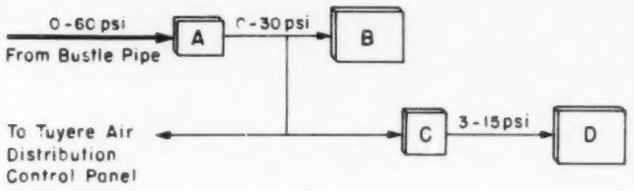
The hot blast temperature recorder-controller will maintain a constant blast temperature to the furnace. This is accomplished by automatically positioning two motor-operated valves which regulate the amount of cold blast air permitted to by-pass the stoves. The valves controlled are the mixer valve and the choke throttling valve. They are electrically interlocked in such a manner that they never work simultaneously, but always in sequence.

The furnace top distributor angle, water charges, large and small bell openings and skip activity are recorded on the sequence recorder. The instrument provides for 12-pen continuous recording.

The furnace top gas temperature recorder records the temperature of the gas entering the dust catcher. It functions to warn the operator of unsafe temperatures that would cause damage to the furnace components.

The venturi scrubber's high efficiency is due to the combination of high gas velocity and water spray pressure. It utilizes the following instruments as shown in Figure 6.

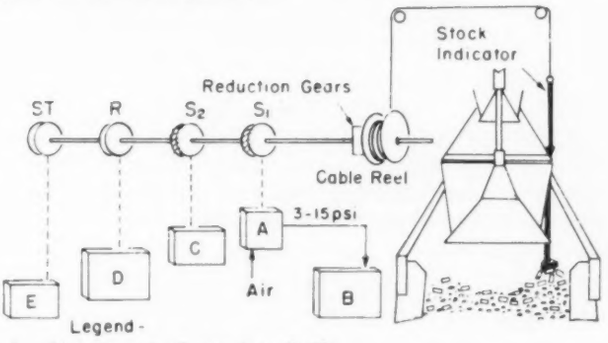
1. Water flow and pressure to the spray nozzle header are continuously recorded by a 2-pen recorder, (D



Legend -

A - Pressure Transmitter Input 0-60 psi, Output 0-30 psi
B - Single-Pen Pressure Transmitter With 0-60 psi Chart (Mud Gun Room)
C - Non-Indicating Pressure Transmitter, Input 0-30 psi, Output 3-15 psi
D - Pressure Recorder On Graphic Panel

Figure 4 — The blast pressure is measured, converted, recorded in the mud gun room and transmitted to the tuyere air control system.



S_1, S_2 - Slidewires On Pinion Gear Shaft
R - Rotary Drum Contact Switch On Pinion Gear Shaft
ST - Selsyn Transmitter On Pinion Gear Shaft
A - Electric - Pneumatic Transducer
B - Single-Pen Recorder On Graphic Panel
C - Single-Pen Recorder In Stock House
D - Signal Light Panel On Cast House Floor
E - Circular Indicator In Mud Gun Room

Figure 5 — The stock line level control has a counterweighted rod suspended by cable from a reel located in the hoist house.

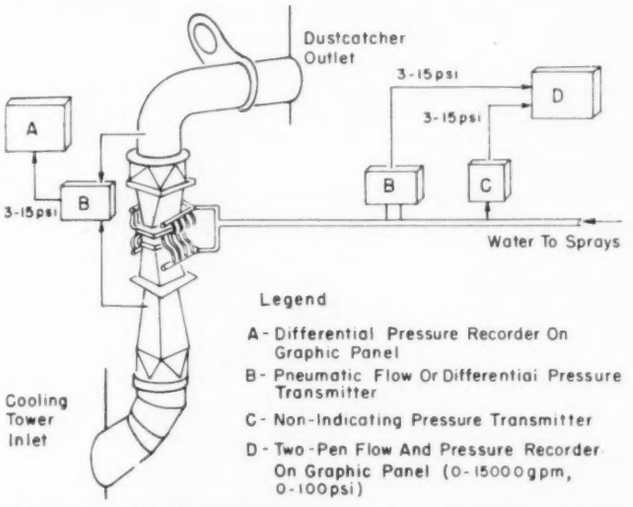


Figure 6 — A differential pressure transmitter measures flow through the venturi providing a continuous check for closing of the venturi.

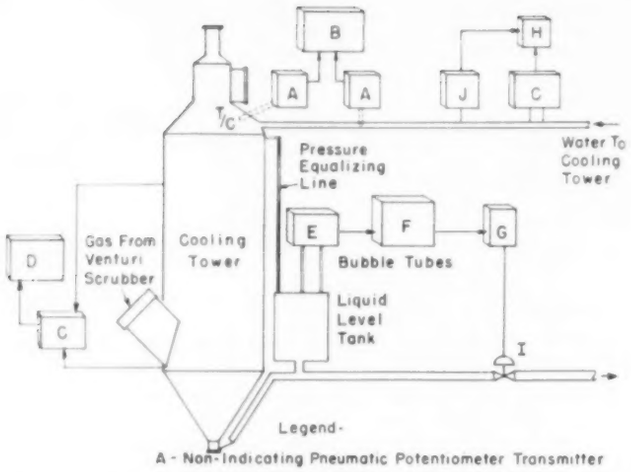


Figure 7 — The function of the cooling tower control system is to measure the water and gas flows, the inlet and outlet water temperatures, the pressure at the nozzles and to regulate the water level in the tower.

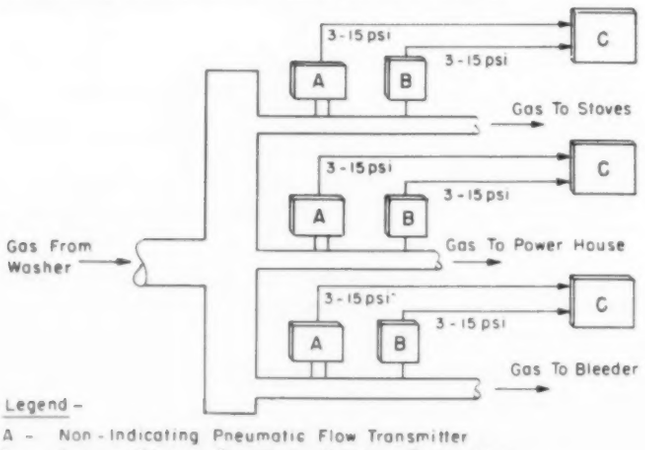
on graphic panel) which receives signals from non-indicating transmitters.

2. A differential pressure transmitter measures the differential across the venturi. This provides a continuous check on possible closing of the venturi section.

For the cooling tower, Figure 7, the gas enters the bottom of the tower and flows upward through banks of tile counter-current to the flow of water. The following instruments are utilized:

1. Gas outlet and water inlet temperatures are obtained by placing thermocouples in the gas header outlet and water spray inlet supply. Pneumatic signals are transmitted to a 2-pen instrument on the graphic panel. Efficient operation of the tower will result in gas cooled to within 5 to 10 F of the inlet water temperature. The

Figure 8 — The gas pressure and flow to the stoves, power house and bleeder are measured and recorded.



water requirements are approximately 15 to 20 gal per 1000 cu ft of gas.

2. The differential gas pressure across the tower is measured by a nonindicating transmitter which sends its signal to a recorder on the graphic panel. The pressure drop will tend to vary as the square of the flow. Any considerable increase above normal of 3 to 5 in. water column at 125,000 cfm would probably indicate a restriction or "plugging" of the tower tile bank.

3. The water level in the cooling tower is controlled by the recorder-controller. The high and low pressure impulses are taken from the liquid level tank adjacent to the tower. This differential is transmitted to the graphic controller and then powers a cylinder actuating a butterfly valve in the overflow line. An alarm system is incorporated into this circuit to sound alarms and also automatically open an emergency dump valve.

4. The water flow and pressure to the sprays is measured by pneumatic transmitters and recorded on the panel.

After the gas leaves the cooling tower it is finally cleaned by passing through electrostatic precipitators. It is now available for the following (Figure 8):

1. Stove gas consumption.
2. Power station boilers.

In each consideration the gas flow and pressure is measured and recorded on the graphic panel.

A dual range precision indicator, Figure 9, allows the operator to check furnaces and stove temperatures by

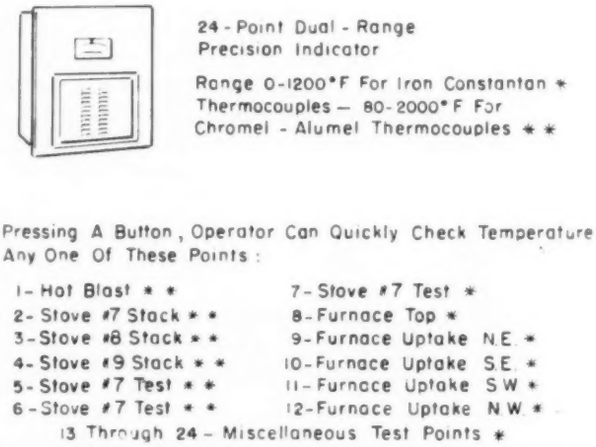

24 - Point Dual - Range
Precision Indicator
Range 0-1200°F For Iron Constantan *
Thermocouples — 80-2000° F For
Chromel - Alumel Thermocouples * *
By Pressing A Button, Operator Can Quickly Check Temperature
At Any One Of These Points :
1 - Hot Blast * *
2 - Stove #7 Stack * *
3 - Stove #8 Stack * *
4 - Stove #9 Stack * *
5 - Stove #7 Test * *
6 - Stove #7 Test * *
7 - Stove #7 Test *
8 - Furnace Top *
9 - Furnace Uptake N.E. *
10 - Furnace Uptake S.E. *
11 - Furnace Uptake S.W. *
12 - Furnace Uptake N.W. *
13 Through 24 - Miscellaneous Test Points *

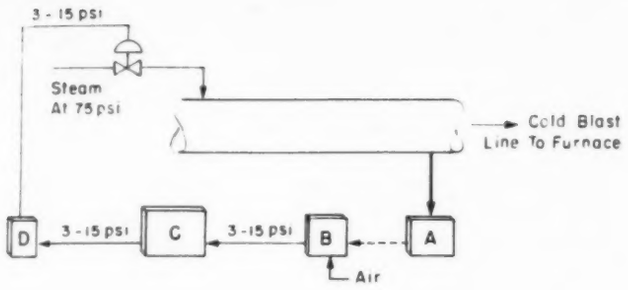
Figure 9 — The dual range precision indicator permits checking any one of 24 furnace and stove temperatures.

means of a multi-range selector switch. These include any one of 24 inwall temperatures, top gas temperature, stove stack temperature and other miscellaneous test points.

Although not graphically represented, moisture control of furnace wind is constantly maintained, Figure 10. A small amount of blast passes through sampling system "A" which in turn transmits to a recorder-controller with a range of 0 to 25 gr per cu ft of wind.

The air delivered to the blast furnace is heated in hot blast stoves. There are three stoves for each furnace. These stoves are filled with checker work of refractory brick which is heated from the combustion of blast furnace gas.

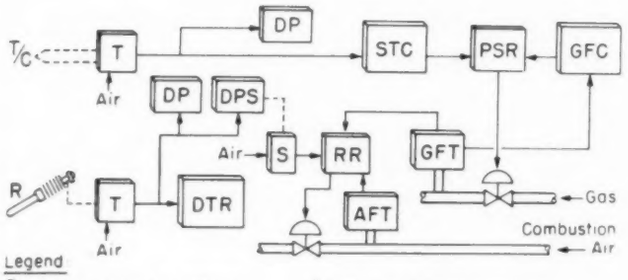
The stove gas flow recorder-controller, Figure 11, for



Legend –

A - Moisture Measuring Unit
B - Non - Indicating Electric - Pneumatic Transducer
C - Moisture Recorder In Power House
D - Pneumatic Control Unit

Figure 10 — The furnace wind control regulates moisture content.



Legend

T/C - Thermocouple In Stack
T - Non-Indicating Pneumatic Potentiometer Transmitter
STC - Stack Temperature Recorder Controller
DP - Differential Pressure Switch To Actuate High - Limit Annunciator Alarm
PSR - Pneumatic Selector Relay
GFC - Gas Flow Recorder Controller
GFT - Gas Flow Transmitter
R - Radiation Sensing Element In Stove Dome
DTR - Stove Dome Temp Recorder
DPS - Differential Pressure Switch To Actuate Solenoid
S - Solenoid Operated Air Valve
AFT - Air Flow Transmitter
RR - Pneumatic Ratio Relay

Figure 11 — The stove gas flow recorder-controller remotely positions a control butterfly to maintain the desired flow rate and provides a signal for the fuel-air ratio controller.

each individual stove maintains the desired rate of gas flow, as manually set, by remotely positioning a control butterfly. Flow is measured and transmitted by a pneumatic signal to a recording control on the graphic panel. In addition the same signal is sent to a fuel-air ratio controller to proportion combustion air.

The stove stack temperature and its interlocking system, Figure 11, is measured by a thermocouple located in the stove flue gas outlet. The signal works through a transducer and records on the graphic panel. The controlling effect of this unit acts as an interlocking temperature override on fuel fired to the stove. When the stack temperature reaches its preset point, pneumatic relays automatically reduce fuel below the preset quantity.

Figure 12 shows the stove dome temperature radiation sensing element sighting down on top of the checker refractory. The element transmits a signal to a recorder-controller which is physically located on the graphic panel. The control effect supplies excess combustion air by changing its fuel-air ratio, resulting in a lower heat input per mass volume. This effectively limits dome temperature.

The stove combustion chamber low temperature cutoff, Figure 12, utilizes a radiation sensing element, sighting directly into the combustion chamber. The signal is transmitted to a temperature indicating controller located on the master automatic stove change panel. This controller provides the safety interlock to prevent stove gas flow from going to the chamber if the temperature is below its safe combustion limit. In this event the stove inspection door and gas valve would have to be opened manually.

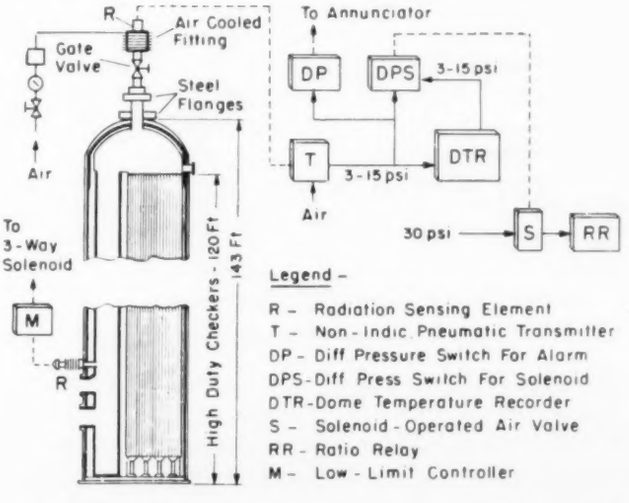
AUTOMATIC STOVE CHANGING

The Fairless No. 3 furnace is equipped with a pneumatic cylinder actuated system. Two stoves are heated with gas while the third is heating the blast. When a stove is sufficiently heated, valves are automatically positioned to open or close with the result that a stove "on gas" then goes "on blast." From a selector switch, Figure 13, located on the graphic panel, any of the following operations may be selected:

1. Gas to blast.
2. Blast to gas.
3. Bottled from gas.
4. Bottled from blast.

A sequence for "gas to blast" would operate in the following manner. After choosing the proper sequence on the selector switch, the operator would momentarily depress the "initiate sequence" push button. This operation selects the proper solenoid valve to supply air to the gas valve sequence pilot. The air pilot connection on the sequence valve positions the plunger to permit air to enter the gas valve actuator cylinder in order to close and at the same time connect the cylinder exhaust to atmosphere. As the piston nears the end of its stroke, it uncovers a port in the cylinder wall and permits air to pass on to the burner shutoff sequence valve. Here again the plunger in the sequence valve is positioned by the air pilot so as to permit air to enter the burner shutoff cylinder and close the valve. This same means of operation is maintained through the various cylinders until all valves are properly positioned. When the last valve in the sequence has operated, which in this instance is the

Figure 12 — The stove dome temperature radiation sensing element, sighting on the top of the checker refractory, transmits a signal to a recorder-controller which changes the fuel-air ratio in such a way as to regulate the dome temperature.



Legend –

R - Radiation Sensing Element
T - Non - Indic. Pneumatic Transmitter
DP - Diff Pressure Switch For Alarm
DPS - Diff Press Switch For Solenoid
DTR - Dome Temperature Recorder
S - Solenoid - Operated Air Valve
RR - Ratio Relay
M - Low - Limit Controller

hot blast valve, a time out switch "triggers" the air supply shutoff and exhausts the system.

This system provides, through the sequence valves, a mechanical interlock between all the valves, and provides a "foolproof" scheme for operating the valves. Exhausting at the end of a complete cycle assures that the valves will remain in a fixed position, and eliminate the possibility of condensation in the lines. In the event of an incomplete operation the valve indicating lights on the graphic panel will locate the trouble area by showing valve position. In addition, an annunciator is provided to facilitate repair.

Stove changing may be accomplished manually by use of handwheels at the valve locations. Needle valves are provided on each cylinder to vent to atmosphere. A stove must be put on blast before the stove which has been on blast is put on gas. The system is interlocked through hot blast valves in such a manner that the hot blast valve on one stove must be open before the stove that is "on blast" can be taken off blast. The total time required for an automatic stove change is five to seven minutes. The actual time to operate the valves requires less than two minutes, and between three to four minutes is required to fill the stoves, and about two minutes to "blow off."

Of all the valves in the automatic sequencing, the burner shutoff, Figure 14, is the most unique. This valve makes possible the fully automatic stove change system. It consists of a body, hood and disk. The disk hangs on a tee bar assembly fitted to the back of the disk. The vertical section of the tee bar passes up through the center reinforcing ribs on the back of the disk and fastens to an internal crank arm on the valve operating shaft in the hood. The horizontal section of the tee bar near the bottom of the disk, extends beyond the disk into two vertical guides in the valve body. An external counterweight is fastened to the operation shaft and arranged in such a manner that the valve is biased to either the open or closed position. To open or close the valve, the lever is moved through an arc of about 110 degrees.

The first action in opening the valve is to move the disk away from the seat. Continued rotation of the valve shaft raises the disk into the hook where it will be out of the path of the gas and air. When closing the valve, the last action of the crank arm on the valve shaft is to bring the disk against the seat. The seating surface on the valve disk never slides across the seating surface on the valve body. During assembly the two surfaces are lapped in, so as to maintain a bottle tight seat.

One final point is that the valves on the No. 3 furnace are identically characteristic to the ones on furnaces No. 1 and No. 2, and we can readily adapt automatic stove changing in the future by merely adding the actuators and component equipment.

In concluding the automatic stove change description, it should be emphasized that in its entirety the designer had safety in mind and planned an absolutely foolproof system.

AIR PROPORTIONING CONTROL SYSTEM

The air proportioning system for No. 3 Patricia blast furnace consists basically of a butterfly valve and an air flow venturi for each tuyere. The furnace has twenty tuyeres.

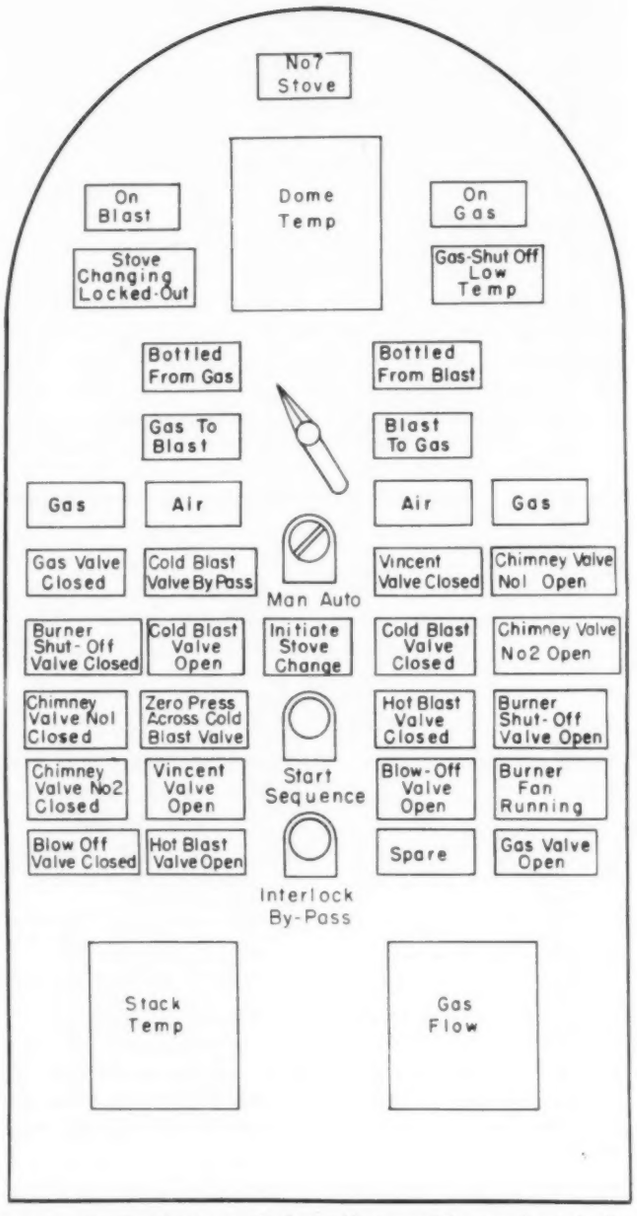


Figure 13—A selector switch on the graphic panel controls the automatic changing of the stoves.

The system is designed to perform the following functions:

1. Maintain automatically the desired air distribution to the blast furnace by metering the air to each tuyere and controlling the flow by positioning the corresponding control valve.
2. Adjust automatically each flow controller from the bustle pipe pressure so that the individual control valve will operate as near their open position as possible.
3. Adjust automatically the tuyere flow set points to prevent any individual control valve from moving to the wide open position and out of control range.
4. Provide individual remote manual control stations to position each tuyere control valve manually when desired.
5. Provide a means for opening all the control valves simultaneously through the use of a master transfer relay.
6. Provide a means of altering the air distribution pattern among the tuyeres as may be required by the furnace conditions. Included in each flow control is a

ratio relay which will make a true ratio change between the flows and not simply bias the tuyere at a high or lower flow rate.

7. The butterfly valves will go to a wide open position if, for any reason, the incoming signal to the pilot valve is interrupted.

The control system is based primarily on maintaining a bustle pipe pressure determined by tuyere valve position. One butterfly valve will always operate near the maximum operating point and will be the controlling or master valve. Any valve can be the master valve automatically, which is determined by the resistance to air flow through the furnace burden for the respective tuyere. The remainder of the valves will be at some normal operating position. Three distinct advantages of using butterfly valves are:

1. Air flow does not materially increase when a valve position is beyond 70 to 75 per cent open. The remaining 25 per cent to full open can readily be adapted into the automatic resetting system.
2. Low torque requirements.
3. Low pressure drop across the valve.

In the control system, for purpose of simplification it was decided that separate "jammed" valve indication was not necessary. The thrust necessary to stall the actuator is considerably greater, approximately 5 to 1, than the torque requirements of the valve. In case of a "jammed" valve, the air flow would either tend to drop or increase. To correct this, the tuyere flow controller transmits to a new valve position signal. Depending on the direction of the signal, a signal light will call to the operators attention if this particular valve is beyond its operating range. The first reaction is for the control system to correct itself. If the air flow through the tuyere is too much or too little, then the operator can switch to manual or visually inspect the faulty tuyere.

When the furnace goes on "check" (reduced wind) the air flow and bustle pipe pressure drop accordingly. The bustle pipe pressure transmitter adjusts the tuyere flow set point controller to a new value, but as the valves were in a normal position, the differential would also drop across the venturi and the valves would probably not move at all. With this arrangement, valve movement is reduced to a minimum whether the furnace is on full wind or check.

SUMMARY

In concluding this report it can be said that the steel industry and specifically the blast furnace division, has taken a long awaited step ahead in the field of instrumentation and control. While we are very pleased with the results to date, we recognize that there is still a job to be done.

The graphic panel has provided the operating personnel with a visual picture of the entire furnace operation. In short, the intricate control of a blast furnace has been clearly shown.

The automatic stove changing system has made it possible to cut the 15-minute stove change time better than 50 per cent. This is accomplished with no more effort than is required to press the "start sequence" button. This system will permit us to control the stoves of numerous furnaces from one master station.

The tuyere air proportioning system enables the operator to have improved control over the distribution of hot blast air to the furnace.

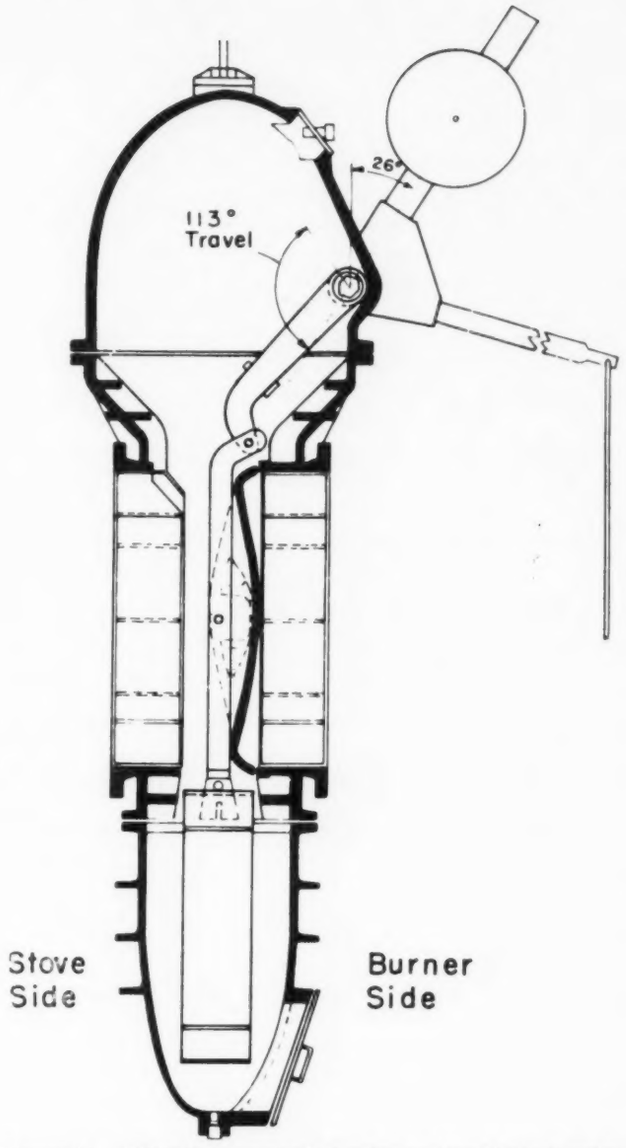


Figure 14 — This burner shutoff valve makes the full automatic stove changeover system possible.

Discussion

PRESENTED BY

GEORGE L. FRENCH, Assistant to Superintendent, Blast Furnace Div., Bethlehem Steel Co., Bethlehem, Pa.

CARL F. HOFFMAN, Superintendent, Blast Furnaces, Bethlehem Steel Co., Sparrows Point, Md.

R. H. WHITE, Superintendent, Blast Furnaces, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

George L. French: The author stated that 2700 tons of iron a day is possible. This means a tremendous amount of material going through the top. I would like to have some idea of the maximum and normal ore

loads in the skip and the approximate skip cycle time. I would also like to know how long the skip is delayed in the pit to permit distributor and small bell operation without stopping the loaded car on the incline at slowdown.

Carl F. Hoffman: There has been relatively little change in the actual blast furnace process from the very beginning. Now we can actually see what is taking place. All this is a step toward a more efficient blast furnace and bigger and better records.

R. H. White: I can say that television in the blast furnace industry is coming into play as we already have one unit showing, to the sintering plant operator, sinter as it discharges at the end of the sinter machine.

As far as 2500 tons per day from a blast furnace is concerned, I can only give you our experience with Hazel furnace at the time we produced our record production. During that period of time, we operated the furnace with a 7-skip charge—four skips of coke, two for ore and sinter and one for flux and miscellaneous materials. The weight of ore and charge was 52,000 to 54,000 lb each. The coke unit, 4 skips at 5900 lb per skip, was 23,600 lb per charge.

With a few minor changes in the stockhouse, the coke unit and the ore and sinter charge can be increased. The type of changes I have reference to are:

1. Changing the direction of the coke chute to more completely fill the skips of coke.
2. Retard the opening of the larry car door to decrease the flow of sinter into the skip making it possible to utilize more skip volume.

With the above mentioned changes, I feel sure we can approach a 3000-ton per day production with our present filling capacity.

With regard to your question of delays encountered waiting on the distributor, I can only say that to date this has not been a problem. ▲

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Why Don't "They" Do Something About It?

United, the North American steel industry can help prevent further inflation which, in the past two years, has reduced its position in many world markets and caused, at least in part, the recent recession. . . . these thoughts were features of the address given at the annual spring conference banquet of the AISE in Buffalo, N.Y., on April 28, 1959.

by H. George DeYoung,
President,
Atlas Steels Limited,
Welland, Ontario,
Canada

HAVING spent 19 years in the American steel industry and approaching 10 years in the Canadian industry, perhaps I, as a former steel mill engineer, can make some comparisons which will be of interest.

There is little difference between a Canadian and an American. It is this fact of similarity which causes Americans to fail to recognize the great differences which do exist. For instance, because most Americans recognize that Canada is geographically larger in size than the United States, they fail to recognize that Canada is a small country in population. Being small in population it cannot support some of the rich schemes which prevail in the United States. Because of the proximity of the countries and because somewhat over one-half of the capital investment in Canada has come from the United States, it is taken for granted that Canada will do as the United States does.

When a wage settlement is made with a United States' union and automatically includes a Canadian subsidiary's wages, the economic facts of Canadian life are not being considered. When a Canadian operation is conducted as a branch of an American plant, the great differences in the countries is again being ignored. It is a federation of heterogeneous thought and different economies. It is a country whose basic policy is international, a low tariff—even a free trade ideology. This free trade philosophy is something most Americans never heard of. This thinking says that only those industries which can compete with world prices should survive. It entirely ignores the fact that new technology and managerial abilities can put efficient manufacturing plants in underdeveloped, low wage lands and upset local markets. The people in Canada, particularly those in civil service, have not recognized Canada as the sixth largest industrial producer in the world and so tend to follow classic thinking as to agriculture and raw materials. Therefore, it is not to be wondered why Americans think of Canada as a "hewer of wood and drawer of water."

However, most Americans just do not think of Canada as a sovereign country when making decisions. This ignoring Canada's sovereignty is the greatest point of friction. Overemphasis of Canadian sovereignty by Americans would pay great dividends in many ways.

By recognizing these differences these countries could build a closer friendship based on their similarities.

However, Canada's greatest fear is that of becoming the 51st state. It does not want to be the 51st state. they want to be Canadians.

The similarities should be used to great advantage. Canada, in spite of civil servants, raw material producers, and agriculturists, is an industrial nation. Twenty-eight per cent of Canada's gross national product is obtained from manufacturing. The economy is based on automobiles just as the United States' economy is. When, because of the influence of American wage settlements, Canada's automotive industry becomes an importer of low wage area cars, its steel business immediately suffers. However, the loss of capital investment for creating more jobs is more serious and will result in the general economy suffering.

The Canadian steel industry is quite generally similar to the American. One other thing the two countries have in common is the wonderful word "they"—as in "Why don't 'they' do something?"

The costs in Canadian mills are tied to America's costs because of international unionism whose goal is equalization of wages. The wage push on Canadian costs is possibly more critical even than on the United States' because of our lower tariff barriers. The results are similar, however, and can be exemplified by a simple statistic on the export of iron and steel products from various countries.

The year 1957–58 was a recession year. One of the reasons for its seriousness in the North American steel mills was its high operating costs which pushed its export markets out of reach. Exports of iron and steel products dropped in most countries but in the United States the drop was 43 per cent in 1958 compared to 1957. In Canada the drop was 31 per cent. The next largest was from West Germany and from England, 11 per cent, while the drop was less than 5 per cent from the other common market countries such as Sweden. Thus, when there is a choice, North American steel is not purchased.

Meanwhile, there has been an increase in imports into the United States. Imagine then what is happening in Canada in the specialty steel business, with duties ranging from free entry from England to 10 per cent from the other low wage areas.

So Canada and the United States have cost economies very similar to each other and can expect costs to rise at every wage negotiation with their unions.

The management of our company has undertaken a study of this problem. We have presented a brief to the Canadian government to get their aid. It helped our understanding, for unless you consider a raised tariff on peaches in the plus column, I can report this is not the place to look for a solution. They are not going to do anything about it.

The American steel industry has "sounded out" the union, and it is safe to analyze their report as indicating negative results. The same is true for Canada. They are not going to do something about it.

One would think that, since there is general agreement between the government, industry and union, that inflation is bad, something could be done about it. However, when either one of these members of our economy speaks of inflation being bad, it is generally in reference to the other fellow. How many people are selling their common stock and buying bonds or real estate? This is considered to be something that should be done to stave off inflation. No, investors are all afraid that there will be a capital gain on the common stock and that they will not have taken the last advantage of the inflationary trend. The unions are using the same philosophy, and our governments are continuing to bring further deficit budgets. Therefore, all merrily go along contributing to inflation while waiting and saying, "Why don't 'they' do something about it?"

We have sounded out industry to see if there is a possibility of all managements joining together to hold the line. I do not expect this will happen either. There exists, today, rigidities in everyone's thinking which stand in the way of a co-operative effort. The union and the government and, indeed, the general public fear that management will take quick advantage of a hold-the-line situation. As long as managements and businesses are distrustful of each other why should we expect other segments of the economy to be trustful? Until management does unite and stop thinking rigidly, as if it were still rugged individualism, there can be no brake applied.

Talking about it does not help. Our company effort has shown that. Being a crusader is not a rewarding thing. At least our management has not obtained much satisfaction from it.

Having come up in one of the older mills in the States, I know that (until recently at least) the word "they" resulted in no adequate planning for the future. This has been responsible in turn for a deal of our present situation.

Our management did nothing to make the younger people managers—one day you found yourself a foreman or a superintendent while mentally you were still a melter, or a designer or a combustion engineer. Then we wondered why "they" hadn't done something about it instead of complaining now about the cost of production. On the other hand, the management wondered why "they," the young people, did not accept responsibility, did not know about depreciation, could not apply overhead to job costs, etc. Why not? Are they not interested?

The principle of "we can solve it" is my suggestion as the route to follow. In building a management the old system of making it as hard as possible for the young people does produce managers. The principle of selecting men with the proper characteristics, who have decided to become managers, and helping them along, produces more and better managers. This system is hard to apply—much harder than the old one where they had to do something, not me.

A more positive approach would help the future of our mills.

If management wants its young men to know how to handle money, it is a better system to teach them how—to work out the proper measurements together—than to just complain about the way they do it.

The steel industry is worried about right answers today—even to putting mechanical brains on the job.

This business of "they" is a common possession of Canada and the United States. I believe the solutions to our common problems are available. Canadian-American relations can continue to improve, even to forming much closer ties of the word "they" is dropped. "We" are the only ones who can do it. ▲

Automatic Continuous Lubrication of Universal Mill Spindles

. . . . lubrication of the rotating bearing segments or "slippers" of universal mill spindles, heretofore a manual application requiring mill downtime, is being done continuously and automatically by centralized lubrication systems which either direct a spray to the outside of the coupling joint, inject oil into an air stream that is fed to the segment faces through holes drilled in the spindles, or feed oil mist to the faces through holes in the spindles. . . .

by William L. Stover,
Assistant Chief Engineer,
Mesta Machine Co.,
Pittsburgh, Pa.

THE advent of centralized lubrication systems many years ago has certainly improved the operation and life of much of the equipment used today in the steel industry. These systems could readily be applied to fixed points of lubrication such as bearings in stationary housings and parts moving on stationary bases. Flexible hoses made possible the extension of the centralized systems to lubricate parts in linear motion, but the lubrication of completely rotating bodies has generally remained a manual application. Lubrication of the bearing segments or "slippers" in universal mill spindles has, until very recently, fallen into this classification.

Manual lubrication of these bearing segments, of course, was easy but with many drawbacks. It was time consuming to grease the eight separate points generally required; grease consumption was high and the general appearance was very messy, to say the least, because the excess grease was thrown over the surrounding equipment.

Many designs have been proposed to reduce the frequency of lubrication and the time required for this operation. Large holes bored in the coupling spade ends formed reservoirs for grease. During rotation of the coupling, grease was forced by centrifugal action to the bearing segment faces. Another arrangement uses a spring-backed plunger in a large bore at the center of the spindle. Lubricant is forced into the chamber by a manual gun compressing the spring. During operation, the spring creates a pressure on the grease forcing it through internal drilling in the coupling to the bearing segments. These two designs reduced the number of times the mill must be stopped for lubrication, but the quantities of grease applied could not be well controlled.

Some spindles have been fitted with manifold grease valves. This reduced the time required to apply the grease and metered the quantity of grease to each surface but still did not help the general housekeeping of the mills, nor did it provide lubrication when the mill was too busy to shutdown for lubrication.

None of the foregoing methods completely satisfied either the mill operators or the manufacturers so a new approach was necessary. Three basic features were desired:

1. Lubricant should be fed to the bearing area continuously and automatically from a central station mounted on the floor.
2. Means should be provided to keep the bearing surfaces clean and free of mill scale.
3. The method proposed should use the lubricant as economically as possible and prevent the excess from being deposited on the surrounding equipment.

The first installation to fulfill these requirements was started in November, 1952, and applied to the motor

Figure 1 — Lubrication of the bearing segments or "slippers" of this universal mill spindle is accomplished by a recirculating lubrication system that sprays the outside of the coupling. This view is facing the motor end of the spindle. The system is enclosed in a drip proof case.

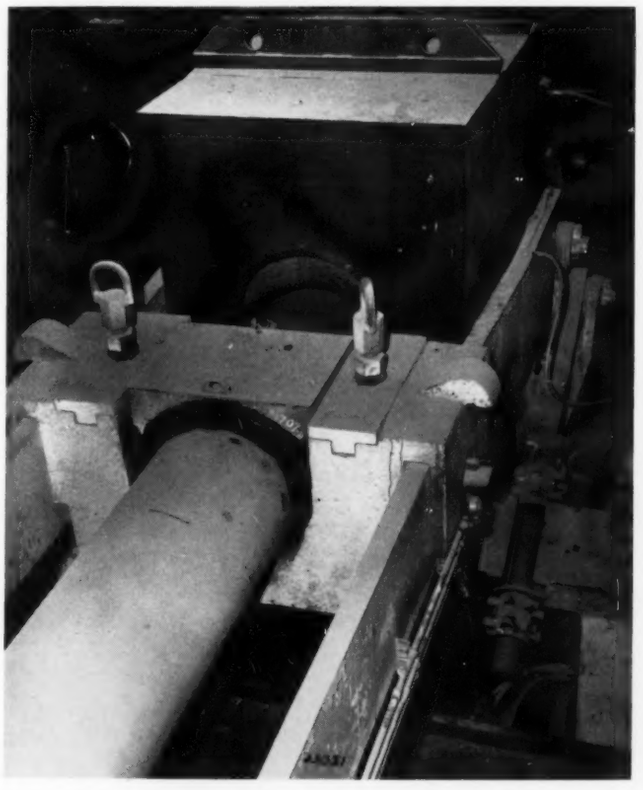


Figure 2 — This underside view, with the lower front panel removed, of the motor end of the spindle shown in Figure 1, shows how the motor end of the case is framed into the partition between the mill building and the motor room.

Figure 3 — The mill ends of these twin-drive universal mill spindles are lubricated by an air-oil system. The multi-plunger pumps and air control (not shown) are located along the building column near the drive end.

end of the universal mill spindles of a twin drive on a 46-in. slabbing blooming mill.

Figure 1 shows a very similar installation, which was put into service in November, 1957. The couplings and bearing segments are completely enclosed in a drip-proof case. Oil is sprayed on the outside of the coupling in the region of the bearing segments so that at some point in the rotation of the coupling, oil is sprayed directly against the end of the bearing segment. This oil is worked into the bearing surface by the rubbing action of the bearing segment as it oscillates during the rotation of the spindles. The excess oil drains to the bottom of the enclosure, which forms a reservoir for the system, and is recirculated. The steel enclosure on the motor side is sealed around the flange of the motor coupling. On the mill side, slots are provided for the up-and-down motion of the spindles. These slots are well protected with channels and drip lips to divert the side drainage around these slots. Spray velocities are kept to a minimum so that loss of oil through the slots has been no problem. The case is split in several sections to facilitate the removal of the spindles.

Figure 2 shows a closer view of the case and coupling with the lower front panel removed. The motor end of the case is framed into the partition between the mill building and the motor room. Note lubricant lines to mill end of the spindle.

The sprays are connected to the circulating system by flexible hoses. The connection to the top spray may be seen in the top right of the photograph. The circulating system employs a 15-gpm gear type pump at approximately 50 psi and uses an extreme pressure lubricant of approximately 2500 SSU at 100 F.

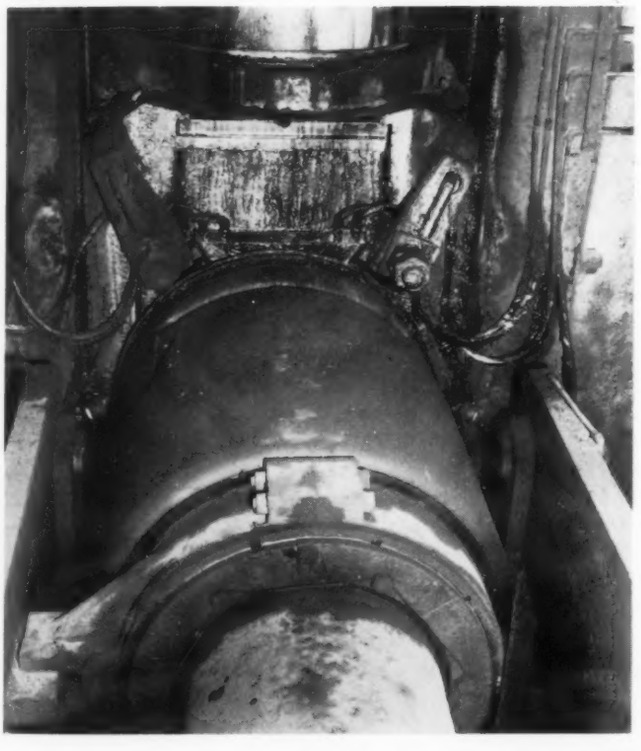
The first installation has been in operation for 5½ years. The bearing segments on the motor end have been changed once in this period.

The material used for the bearing segment is a manganese bronze, and the couplings are carbon steel. While these materials have proved satisfactory, it is only fair to state that no attempt has been made to improve this service with the use of other materials.

This design of enclosure is very satisfactory for the motor end, but it is not very applicable for use on the mill end. Due to the high lift of these mills, openings in the case would be excessive, and roll changing would be more difficult because of limited vision when entering the roll into the spindle coupling. Adjustment of the bearing clamps would also be most difficult on the drive side due to limited working room. For these reasons another style was desired. However, the same three prerequisites prevailed, namely, continuous lubrication, protection of the bearing segments from dirt, and cleanliness of the surrounding area.

Lubricant can be fed to the bearing segments continuously by dripping oil on the outside of the coupling. One mill is using this method at the present time, but it offers no protection from dirt and scale. To overcome

Figure 4 — In order to provide a transition from the stationary piping, a split collar was placed around each coupling head.



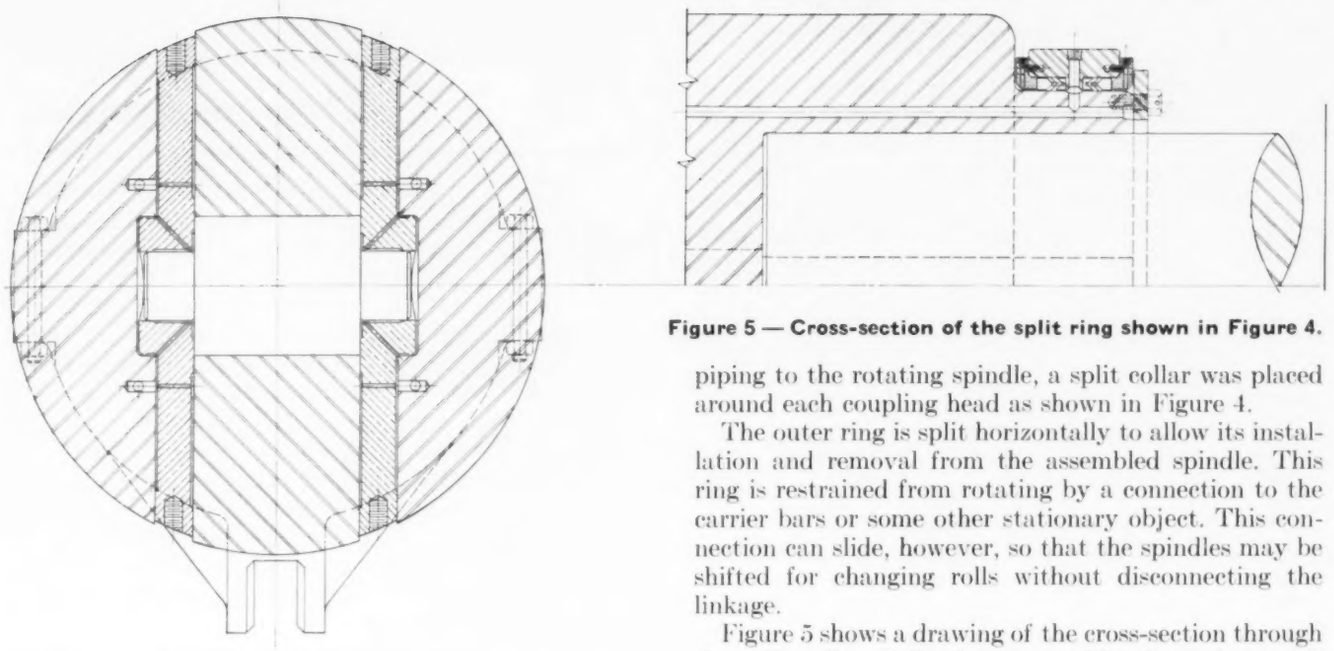


Figure 5 — Cross-section of the split ring shown in Figure 4.

this it was decided to feed the lubricant internally and keep the bearing surfaces under pressure.

To accomplish this, air is fed internally through drilling in the coupling to the bearing surfaces and allowed to escape to the outside. In doing so there is a tendency to blow the dirt and scale away from the coupling. At present the air is supplied from the mill service system and reduced to approximately 30 psi by pressure regulators. Oil is injected intermittently into the air lines following the regulators and is pushed along the lines to the couplings by the air. No attempt is made to atomize the oil in this type of a system.

The oil used is a 2590 SSU at 100 F and is injected into the air lines by a multi-plunger pump at the rate of approximately two cu in. per minute per coupling. The oil to lubricate the packing glands and collar bushings is fed directly from the pump instead of using the air-oil mixture. The air pressure and the rate of oil flow is still in the experimental stages. Greater quantities of oil were first used as a safety precaution but were reduced to the present figures based on observations of excess oil being used. Additional experience may further reduce these figures.

Figure 3 shows a recent installation of universal mill spindles on a twin drive. The drive end is lubricated by an oil spray enclosed in an oil house. The mill end is lubricated by the air-oil system. The multi-plunger pump and air control (not shown) are located along the building column near the drive end. Lubricant pipe and hose for the mill end are fastened to the carrier bars, and for the top spindle, travel up and down with carrier bars and the spindle.

Over the bottom spindle a shield has been installed to protect the bearing segments from the flying scale coming directly from the ingot. These bottom slippers are the most difficult to keep clean and consequently are the ones which wear the fastest. This shield, which is fastened to the scaleguard, is not as substantial as it should be due to the limited clearance at minimum opening of the rolls. However, if it only lasts for a few roll changes, it is worthwhile.

In order to provide a transition from the stationary piping to the rotating spindle, a split collar was placed around each coupling head as shown in Figure 4.

The outer ring is split horizontally to allow its installation and removal from the assembled spindle. This ring is restrained from rotating by a connection to the carrier bars or some other stationary object. This connection can slide, however, so that the spindles may be shifted for changing rolls without disconnecting the linkage.

Figure 5 shows a drawing of the cross-section through the split collar. Split chevron packing is used on each side of the center land in the collar with split bronze glands, bolted to the collar, to hold the packing in place. The whole assembly is held on the coupling by the split retainer plates bolted to the coupling. These bolt heads are wired together to prevent the bolts from coming loose. The chevron packing rings are made of rubber, the top and bottom adapters are made of phenolic resin with the halves clamped together by garter springs. Rock hard compressed asbestos shims are provided to adjust the stack height to produce the lightest possible pressure on the packing lips with the glands drawn up solid. Notice the packing rings are arranged with the lips turned away from the pressure. This was done intentionally to prevent a build-up of excessive pressure in the system and to obtain the maximum lubrication for the rings. The sealing surface of the coupling is hardened and ground to insure the long life of the packing. At the present time the speed of rotation at the rubbing surfaces is limited to a rubbing speed of approximately 1000 fpm. Experience may show that these speeds may

Figure 6 — This bottom view of the top spindle shows the hose connection to the glands and center part of the split collar.

be exceeded. However, since this seal is the heart of the whole system we are proceeding cautiously on this point.

The connection from the supply system is made by means of one flexible hose to the stationary collar, through the collar into the annular groove inside of the collar. Four holes lead the lubricant to the bearing surfaces. The outlet hole in the coupling lines up with grooving on the bearing segment to distribute it over the bearing surface. This hole also lines up with a hole through the bearing segment to carry the lubricant through the segment to lubricate the surface of the spade. The oscillating and rocking motion of the slippers quickly spreads the lubricant over the bearing surfaces.

Figure 6 shows a bottom view of the top spindle and shows the hose connections to the glands and center part of the split collar.

On another installation an air mist system is used to supply pressure and lubricant to the bearing segments. A commercially available oil mist generator is used to supply the system. This lubricates not only the bearing segment but the glands as well.

The generator has a 3-gal reservoir and is equipped with automatic heaters to maintain an even viscosity of the oil. This is important to insure a uniform flow of lubricant and allow the use of oils having a viscosity of 900 to 1000 SSU at 100F with extreme pressure additives. The generator is connected to the mill air supply and has a built-in water separator and air pressure regulator. This pressure may be varied between 5 and 45 psi, with air consumption of 7 to 24 cfm. We expect to use between 30 and 45 psi to keep the coupling under pressure.

Oil consumption may also be regulated between 1.6 and 6.4 ounces per hour at 45 psi.

The same split collar and packing is used for the oil mist system as was described for the air-oil system. Also the same drilling in the coupling and grooving in the slippers is employed. Condensing fittings are necessary for the gland lubrication with the air mist system, but no condensing fittings are necessary for the segments as the oil passages serve to condense the oil. Thus it is apparent that the spindle arrangement may readily be used with either system as desired.

Neither the air-oil system nor the oil-mist system described have been in service long enough to determine the degree of success of these applications. Short range tests indicate, however, that they will be successful in lubricating the spindle continuously, require less lubricant and provide a cleaner appearance for the mill area. The actual extension of slipper life is yet to be determined.

Aside from these basic fundamentals, there are other important gains to be made as a result of better lubrication and slipper life. It is expected that spindles with these systems will operate longer with small clearances in the slippers and thus reduce the shock to the rotating system during reversal of the mill. This should result in fewer broken spindles, less maintenance on the main motors and quieter operating conditions. All of these factors seem to dictate the use of these or similar systems on modern mills.

So far limited descriptions of systems as applied to reversing mills are had. We see no serious limitation to using these systems for mills having a single direction of rotation. Continuous lubrication that can be controlled has advantages in almost all applications.

Discussion

PRESENTED BY

A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

Member: It has been rather obvious in seeing many of these large installations that the life, whether it was a standard coupling, a roll neck bearing, or a spindle, is not so much a function of the compressive strength of the materials as it is a function of the adequacy of the area in carrying all the lubricants. The author has very nicely pointed out the way to get the lubricant in contact. On most large hot mills of this type, due to the rather large pinion stands and the small roll diameter of the work rolls, you have plenty of space in the drive and on the roll neck end.

It comes down to the area for carrying the torque you are trying to transmit. This is apparent in gear-type spindles, and I am sure there are a lot of modified teeth used. On rolling mills, for contamination purposes, the unit should be boxed up in a housing for protection and have continuous lubrication. There have been steps taken to provide rotating distributors on the ends of pinion stands to continuously pump oil all the way through hollow shafts and through various types of spindles, including gear-type, because frequent shutdowns for wash downs and cleaning cannot be tolerated. This is a critical point on lubrication of all types of spindles. I would like to compare it with the illustration of having the right amount of area and the right type of lubricant with the operation of the rear end of a car. If you want to find out what happens when the wrong areas and the wrong lubricant are used, try putting crankcase oil in the differential. You have the same problem.

A. E. Cichelli: That comment concerning the rear end of a car is all right but should be qualified for other mechanical devices. I do not think the compressive strength and other metallurgical properties of the mating parts should be discounted and all of the responsibility placed on the lubricant.

I might add, some of our experience is that the grade and type of lubricant is not as important as having a lubricant retained in the coupling. In a recent survey to determine the results obtained from different kinds of lubricants as well as from different methods of application, the one outstanding fact we learned was that the coupling with a continuous supply of lubricant was the one that lasted the longest, the nature of the lubricant being only secondary.

A reference to extreme pressure lubricants brings to mind a point to be made regarding the usefulness of such lubricants, generally, not just in couplings. All have temperature and pressure ranges in which they operate best. Some types are useless beyond a specified temperature whereas others can only function above certain temperatures. Perhaps these facts may explain why oftentimes extreme pressure lubricants do not improve performance in specific cases. ▲

How To Determine Continuous Annealing Line Output For Different Strip Widths and Thicknesses

by R. A. Andreas,
Industrial Heating Dept., General Electric Co., Shelbyville, Ind.

Calculated required annealing strip speeds and their tonnage productions, in graph form, for different thicknesses and widths of strip are valuable aids for operating continuous annealing lines.

MANY steel mills are currently changing over their batch strip annealing equipment to continuous annealing lines. In the past, where several different sizes of batch furnaces were operated to handle the various widths of strip, the continuous annealing line was designed to handle all of the various widths from the mill.

Normally, continuous annealing furnaces are designed for a given rated capacity based upon some particular strip width and thickness at a given rated line speed, for instance 30 tphr of 0.010 in. thick x 30-in. wide strip at 1000 fpm. The operators of this equipment, however, have to know the operating characteristics for the various widths and thicknesses of strip to be handled by the furnace in order to properly anneal these strips.

The curves in Figure 1 may help furnace operators and purchasers determine the over-all production characteristics of their continuous annealing lines. This figure illustrates per cent furnace capacity versus per cent furnace line speed for various strip widths and thicknesses. These curves are made for a furnace having a basic strip 0.010 in. thick and 30 in. wide. Production is based on heating the basic strip to 1350 F in 18 sec using gradient heating of a 1650 F furnace temperature. Strip variations are 18, 24, 30 and 40 in. wide and 0.0075, 0.010 and 0.025 in. thick. These curves were plotted by using the following equation:

$$\left(\frac{W_1}{W_2}\right)(\text{fpm}_1)\left(\frac{T_1}{T_2}\right) = \text{fpm}_2 \qquad (1)$$

W_1 = basic width, in.
W_2 = running strip width, in.
T_1 = basic thickness, in.
T_2 = running strip thickness, in.
fpm_1 = basic line speed, per cent
fpm_2 = running line speed, per cent

Similar curves can be made for other strip widths and thicknesses by using the above equation.

From equation (1) it is seen that strip speed is a function of strip width and the thickness being run. For example if 0.010 x 40-in. wide strip is to be run through a rated 1000 fpm furnace the running strip speed would be:

$$\left(\frac{30}{40}\right)(100)\left(\frac{0.010}{0.010}\right) = 75 \text{ per cent}$$

or 0.75 x 1000 fpm = 750 fpm.

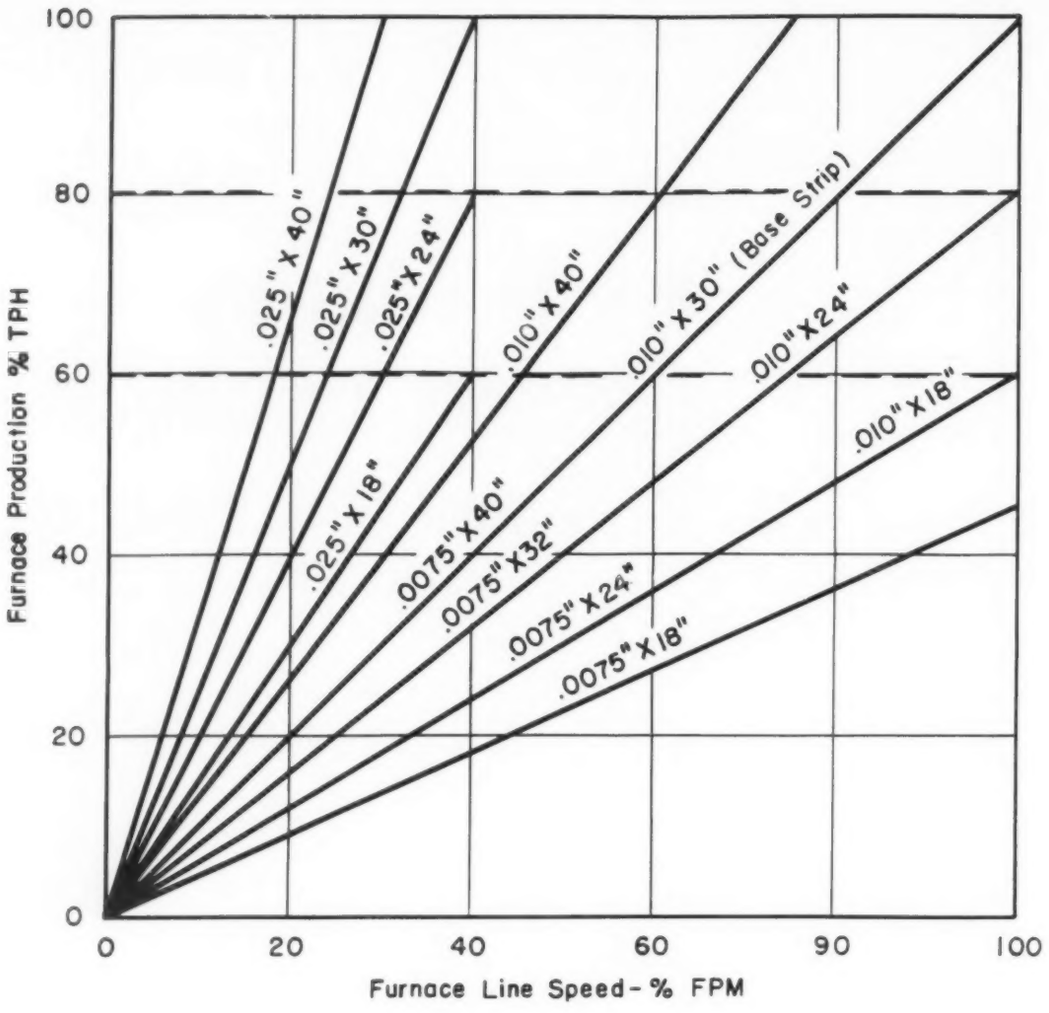


Figure 1 — These are line speed vs tonnage production curves for various strip gages and widths. Heating furnace capacity sets limits for speed and tonnage in some cases.

If 0.025 by 30-in. wide strip were to be run the strip speed would be:

$$\left(\frac{30}{30}\right)(100)\left(\frac{0.010}{0.025}\right) = 40 \text{ per cent}$$

or 0.40 x 1000 fpm = 400 fpm.

If 0.025 by 24-in. wide strip were to be run through this furnace the strip speed, given by equation 1, would be:

$$\left(\frac{30}{24}\right)(100)\left(\frac{0.010}{0.025}\right) = 50 \text{ per cent}$$

or 0.50 x 1000 fpm = 500 fpm.

However, it should be noted from the curve that the maximum speed that 0.025 x 24-in. strip should be run is 400 fpm (40 per cent) to be properly annealed, for the strip would not heat the proper length of time and would not reach 1350 F. It was stated that 0.010-in. thick strip heats to 1350 F in 18 sec. Therefore, the 0.025-in. strip will require 45-sec heating time (assuming that heating time is directly proportional to strip thickness), and the line speed required to give proper heating time would then be:

$$\frac{1000 \text{ fpm x } 18 \text{ sec}}{45 \text{ sec}} = 400 \text{ fpm}$$

1000 fpm and 18 seconds are for the basic strip.

The furnace production for the 0.025 x 24-in. strip as shown on the curve would be 80 per cent of rated production. This is due of course to narrow strip having less pounds per feet of length than rated strip. The production, therefore, for strip widths less than basic strip width is:

$$\left(\frac{W_2}{W_1}\right)(\text{Tphr}_1) = \text{Tphr}_2$$

If narrow thin strip such as 0.0075 by 18-in. wide were to be run through the furnace, the calculated line speed would be:

$$\left(\frac{30}{18}\right)(1000 \text{ fpm})\left(\frac{0.010}{0.0075}\right) = 2208 \text{ fpm}$$

This is 220.8 per cent rated speed which is beyond the rating of the equipment and, therefore, from the curve, furnace production would be limited to approximately 45 per cent capacity by maximum line speed of 1000 fpm.

It is evident from the above information that:

1. Rated furnace production cannot be maintained when narrow strip is being run.
2. At wider strip widths the line speed must be reduced because of the limited designed heating capacity of the furnace rated on basic strip.
3. Heating time is a function of strip thickness and, therefore, line speed is a function of strip thickness. ▲

Rapid Heat Acceleration
in the Soaking Pits at Fairless Works

. . . . new soaking pit control accelerates the heating of ingots to their drawing temperatures by regulating the furnace firing rate in such a way as to keep the heat transfer rate to the center of the ingot at a maximum value limited only by the maximum permissible surface temperature (the drawing temperature) of the ingot . . . .

by J. Leo Hagan,
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Utilities Dept.,
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THE soaking pit operation at Fairless Works has been considerably improved over similar installations because of the heat acceleration principles incorporated in the original design. In order to more fairly examine this topic, some consideration must first be given to the physical structure of the pit itself.

The pit furnaces are of the two-way, nonreversing, top-fired, recuperative type arranged in 10 batteries of two furnaces each. The batteries run from north to south in line with the 45-in. mill. Each pit is rectangular in plan 14 ½ by 20 ft and 15 ft deep, and has a capacity of 140 tons of steel. The two burners in each pit fire diagonally across the pit, 3 ft below the curb. The burners are 4 in. in diameter and burn a maximum of 20,000 cu ft of gas per hr per burner.

The control for each battery of two pits is in a control house which has the panel boards for the two installations and space behind the panel boards for mounting of all regulators.

Each furnace has the following control equipment, shown in Figure 1, mounted on the panel:

1. Temperature controller and strip chart recorder.
2. Fuel proportioning relay.
3. Waste gas proportioning relay.
4. Fuel air flow recorder.
5. Air and gas balance indicator—north.
6. Air and gas balance indicator—south.
7. Furnace pressure recorder.
8. Fuel-air ratio regulator.

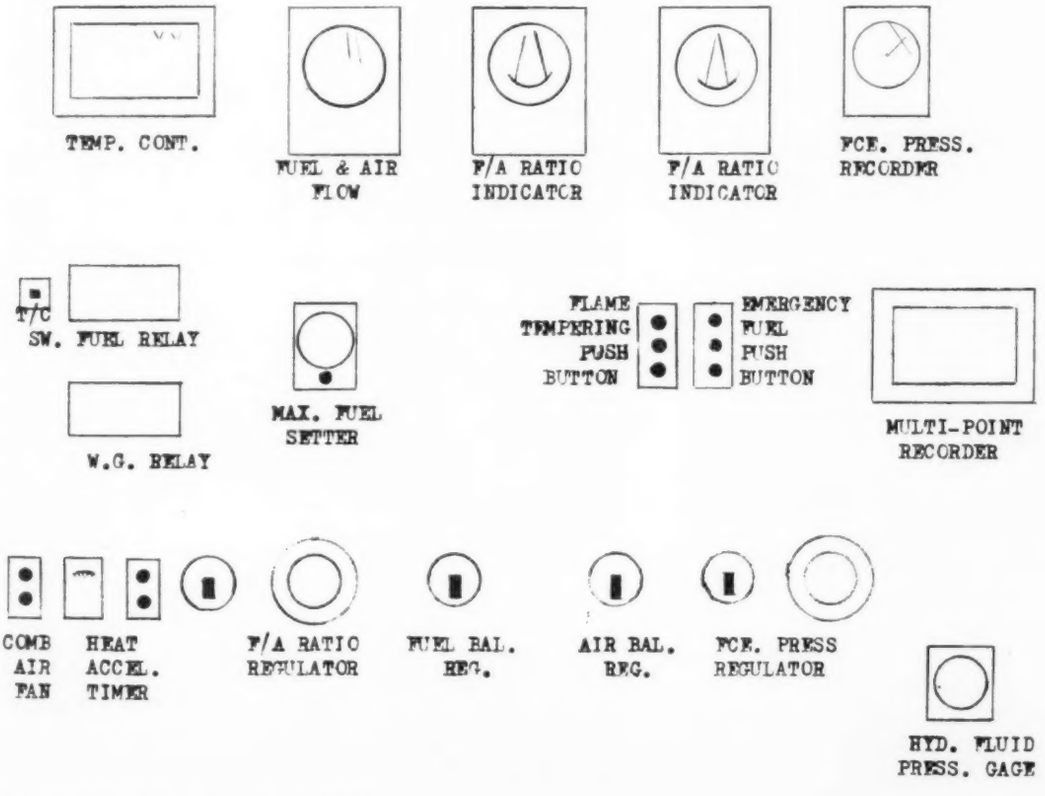


Figure 1 — Each furnace has this set of controls.

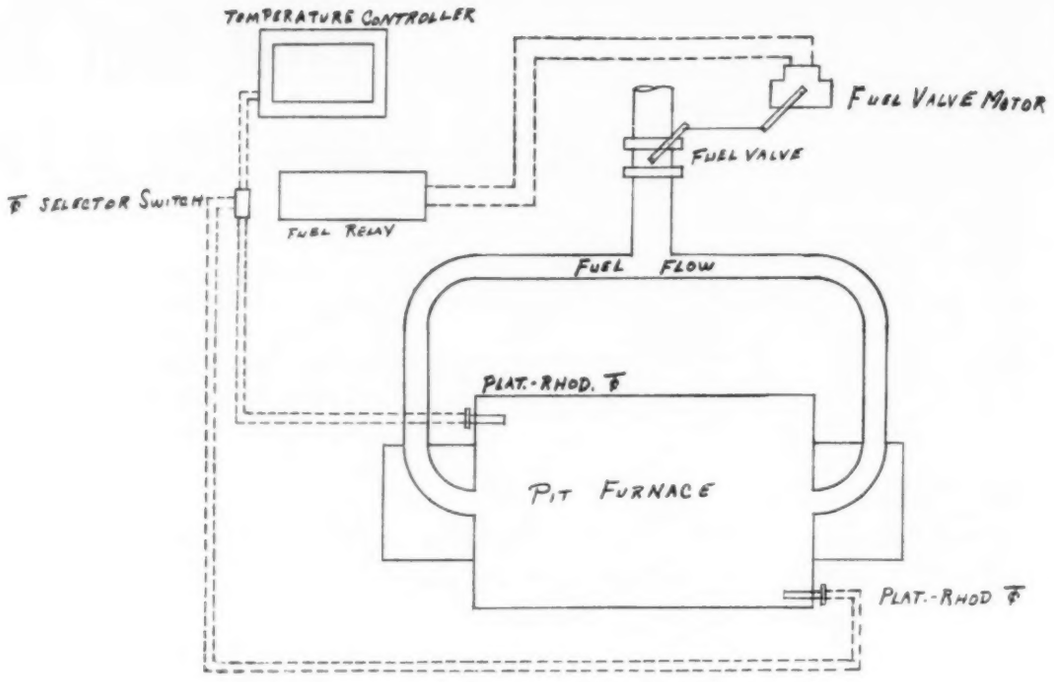


Figure 2 — Temperature control scheme for the pits.

9. Air balancing regulator.
10. Fuel balancing regulator.
11. Furnace pressure regulator.
12. Multi-paint temperature recorder for use on two furnaces.

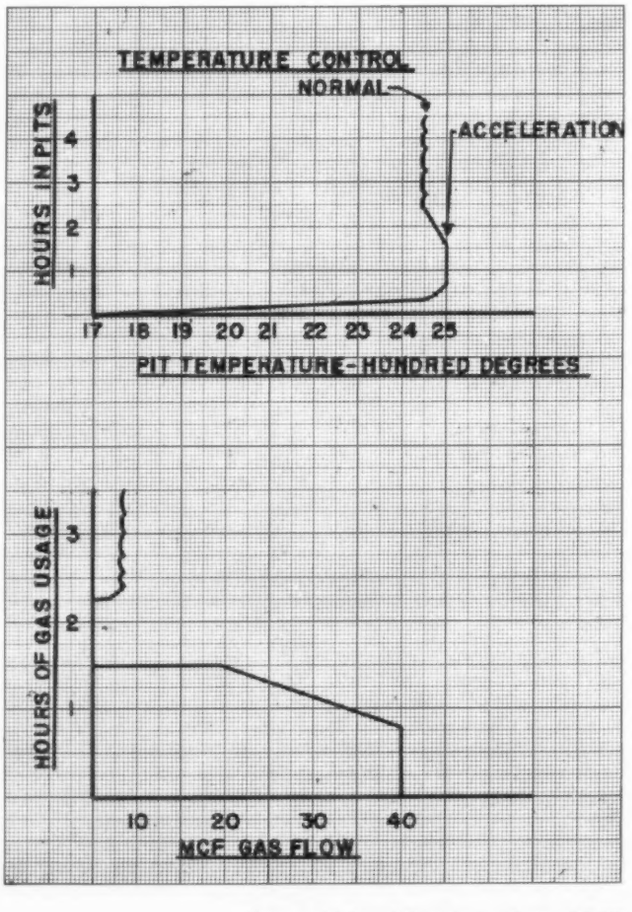
Fuel for the soaking pits comes from a mixed-gas system which is supplied by coke-oven gas as a base fuel and supplemented, on pressure demand, by a mixing station which adds natural gas and air.

It is a fundamental fact in heating that the temperature of the surface of a charge of steel lags behind the furnace temperature. If this were not true, heating would be impossible. Also, within the ingots themselves are temperature differences. In fact, on short track time heats, heating is accomplished by taking heat away from the center of the ingot and adding it to the surface. The problem of fast heating becomes one of bringing the surface of the charge to temperature as quickly as possible or metallurgically desirable, and then allowing sufficient time for the temperature difference within the ingot to equalize. Heating of the steel surface can be performed rapidly because it is performed on all four sides.

In part, the rate of heating is a function of fuel flow. However, the disadvantage of present heating practices is that temperature control is based on furnace temperature rather than steel temperature. This means that, for a given heat, when the furnace reaches temperature and the fuel cutback begins, there may be a large difference between the furnace and the steel temperatures. It must be recognized that the fuel cutback only indicates a change in the rate at which the steel may absorb the heat and does not indicate that the surface is at temperature. In order to avoid the fuel cutback, some operators long ago decided that the thing to do would be to increase the control point 25 to 50 F, and after a certain amount of time, return to the furnace and lower the temperature to the drawing temperature. With this heating practice, if the operator was late in returning, the result was washed or burned steel.

This same type of heating has been accomplished at the Fairless Works soaking pits with automatic controls. It is called "heat acceleration." By means of a control it is possible to maintain a high fuel rate for a timed interval in order to allow the pit temperature to exceed the desired drawing temperature. Best results

Figure 3 — These pit temperature and gas flow graphs show how the pit control functions when set for a charge of 12 ingots (2-hour track time) to be rolled during the same turn.



have been obtained with a 50 F temperature differential between the two control indices.

Temperature control on the pits is initiated from either of two thermocouples (platinum-platinum rhodium) reading temperature at opposite ends of the pit on the same elevation as the burners as shown in Figure 2. A selector switch is mounted on the panel so either thermocouple can be used. The controller is an electronic type milli-volt instrument equipped with a double index. The first index is the normal set point, and the instrument can be operated in the normal manner. The second index is energized from a push button station on the panelboard. This index becomes the set point when energized. The set point remains at the second index until the fuel flow is reduced to a predetermined figure plus whatever length of time has been set on a timer which is energized when the gas flow reaches the predetermined figure. This predetermined gas flow has been set at 18,000 cfhr, and the average time on the timer is five minutes. This second index is incorporated into the circuit as a heat acceleration device so that during the time when the ingot is capable of absorbing heat, at a high rate without burning or melting the outside of the ingot, a temperature differential can be established between the outside and inside of the ingots in order to raise the inside temperature of the ingot.

To use heat acceleration the operator must first determine the type and size of charge, track time and roll time. He then sets his controls for this condition. For example, assume a charge of 12 ingots with a track time of two hours, are to be rolled in the present turn. The operator sets the heat acceleration set point at 2500 F; this set point is at the righthand side of Figure 3. The normal set point is set at 2450 F which is the pit drawing temperature and is the one on the lefthand side of Figure 3. The heat acceleration timer is set at five minutes in this example. The operator chooses the time and bases it on track time and ingot size. The heat acceleration set point is the control point and holds the gas flow to the pit at a maximum flow of 40,000 cfhr. This temperature is maintained until the temperature of the pit has been at the acceleration control point long enough for the fuel demand to cut back to 18,000 cfhr. As the predetermined minimum gas flow of 18,000 cfhr, on the acceleration cycle, is reached a timer is energized by the control drive unit and the 18,000 cfhr is held for five minutes. When the timer has timed out, the control point is shifted automatically from the heat acceleration set point to the normal set point which then becomes the control point. In transferring from the heat acceleration set point to the normal set point, a time period of 15 to 45 minutes is consumed during which time the gas is on minimum flow. After this time the fuel will increase to maximum flow for a short period and again return to minimum flow until it is time for the steel to roll.

The degree to which acceleration can or should be used is actually a function of tapping schedules of open hearth furnaces as it relates to the necessity of pit storage or fast heating to meet rolling mill schedules. Fuel economies and steel quality must also be considered along with the versatility of existing control circuits and ingot sizes. All of the above mentioned

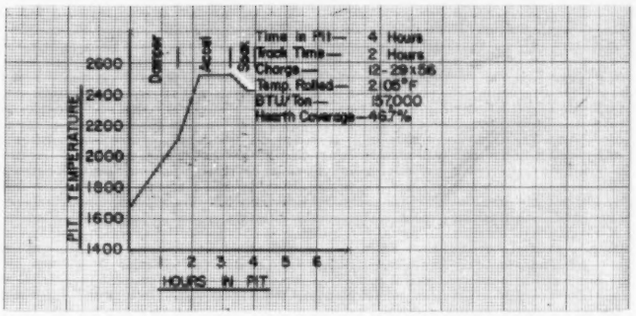


Figure 4 — This heat, although a typical example of good fuel economy inasmuch as it took only 40 minutes to bring the pit up to the desired temperature, required an excessive acceleration heat time (one hour) because the excessive damper period (one hour) cooled the core of the ingot too much.

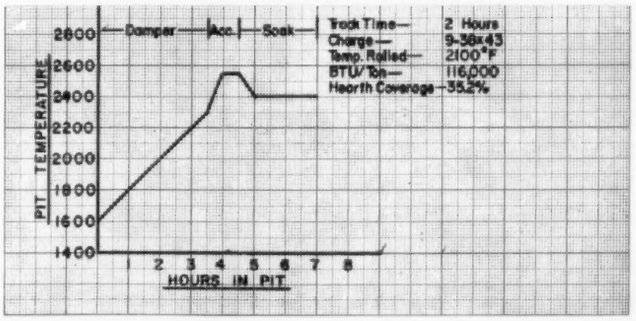
variables contribute to a constant study and revised recommended practice.

Chief among the factors affecting acceleration is track time. Track time may be defined as that time interval between start of pour of the first ingot at the open hearth and the delivery of the stripped ingot to the soaking pits for charging. It is easily understood that short track time will contribute much in the way of fuel economy and is in itself an element of better heating practice. The hotter the ingot is when received at the soaking pits the smaller will be the amount of gas required for heating. At present the average normal track time is running between 2¼ to 2½ hours.

Many times it becomes advisable to charge a pit and damper it immediately without firing any fuel in order to give the core of the ingot an opportunity to solidify. This practice is necessary on large size ingots charged after a short track time. However, it is also expedient at other times when the demands of the 45-in. mill will not be felt for several hours, to damper a pit in order to conserve fuel and not have the steel ready for rolling too far in advance. Along with this, of course, is the practice of charging a pit heavy at a time when the mill is down or at a time when the time factor would not allow this steel to be ready for the present rolling turn. As the rolling time approaches, the pits are not charged as heavily.

Normally an average size ingot must have at least 2-hr track time before it would be safe to begin the heating cycle. An ingot of this size charged without this 2-hr track time would then again have to be dampered for a period equal to the two hours before it could be heated. Large size ingots require up to three hours track time. Large ingots charged with a track time

Figure 5 — This heat of large ingots, having short track times and charged well in advance of roll scheduling on the 45-in. mill, has a good Btu-per-ton average.



less than three hours are dampered until this 3-hr period has been reached.

In order to illustrate more clearly examples of heating practice and acceleration as it is employed, consider the example shown in Figure 4.

This heat is a typical example of good fuel economy. Notice the excellent track time and the heat transfer by dampering the pit without firing. The pit increased in temperature from 1680 to 2100 F without any fuel. This size ingot is considered a large ingot and consequently should be three hours old before heating. It took only 40 minutes to bring the pit up to the desired temperature. However, the pit had to be heated for an hour at this temperature before it went off acceleration, a sign that the heat transfer from the fuel to the ingot proceeded at a slow rate. The damper period in this example was too long. This heat was dampered for 1½ hours, one hour would have been long enough. The longer damper period cooled off the core of the ingot too much, and consequently fuel was burned for a 1-hr period after the pit reached the accelerated temperature.

Figure 5 illustrates a charge of large ingots charged with good, or short, track time, well in advance of the 45-in. mill schedule. Notice again the heat transfer from the center of the ingot to the pit before any fuel was actually fired. The acceleration cycle here was completed in one hour, the quantity of gas used was very small, hence the good Btu per ton average.

Notice in this heating curve (Figure 6) the time the ingots were in the pit, 7½ hours. This charge represents a heat charged at the start of the roll turn. It was a heavy charge, had a good heat cycle, possibly dampered a little too long, however, the Btu per ton was excellent.

This heat cycle, Figure 7, illustrates a light charge and rapid acceleration. Many times when steel reaches the mill about midway through the rolling turn, the pits are charged lighter in order to have the steel ready in time to be rolled on the same turn. Normally an ingot of this size would require more age before being reheated. This is a large ingot and in normal practice it would have been 2½ to 3 hours old before it would be reheated. However, this steel rolled well, had good scale and was free of tears or cracks. Notice, however, the time the steel was in the pit, 2½ hours, almost an hour and a half of which was soaking time, a time which could have been a half hour instead. This cycle illustrates another potential of acceleration, the ability to have steel ready for rolling in a time which is equal to the original track time.

This charge, Figure 8, represents a heat of steel received at the pits too late for the present rolling turn. It should be apparent that there was no need to heat this steel fast, consequently, the heater fired at one-half of the normal fuel rate. He accelerated for a longer period, but over-all fuel usage was conservative as is evidenced by the good heating rate.

In the preceding heat curves an attempt has been made to show how steel is heated and how heat acceleration is employed. It must be remembered, as was previously stated, that many factors affect the extent to which acceleration may be used.

Acceleration is governed to a large extent by the

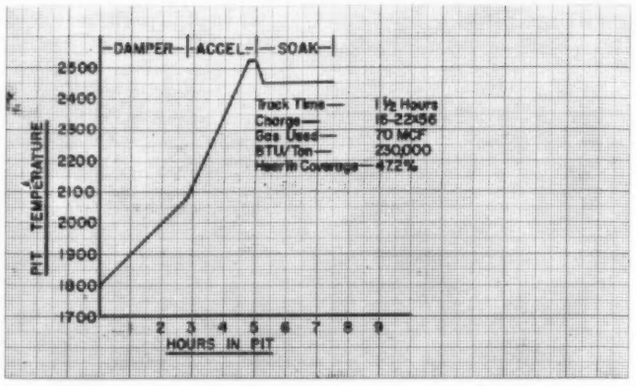


Figure 6—For a heavy charge made at the start of a roll turn, the Btu-per-ton average was excellent although possibly the heat was dampered a little too long.

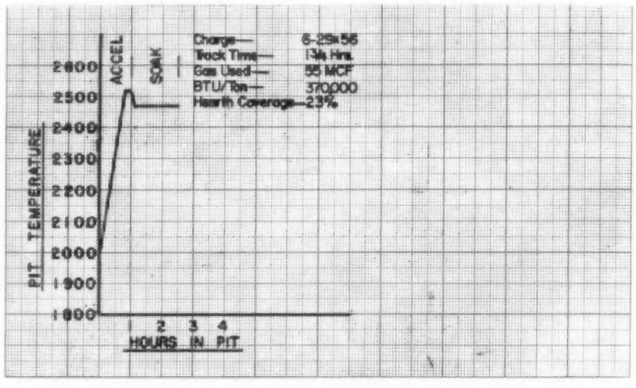


Figure 7 — This heat cycle, illustrative of a light charge and rapid acceleration, shows the inherent capacity of accelerated heating to have steel ready for rolling in a time which is equal to the original track time.

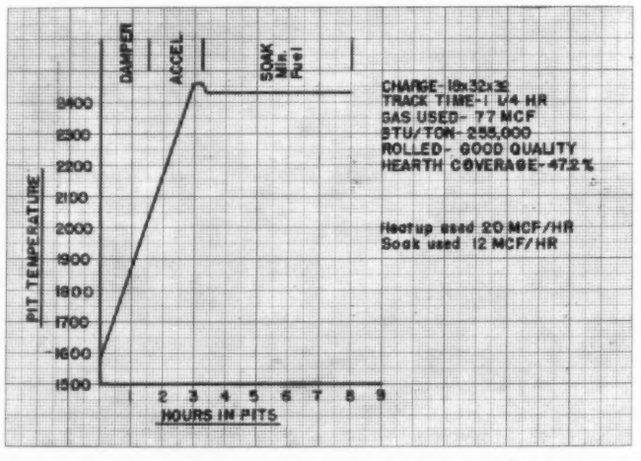


Figure 8 — This heat of steel was received at the pits too late for the rolling turn so there existed no need for fast heating. The acceleration heat time was long but efficient as evidenced by the good Btu-per-ton average.

quality demands placed on heating by the metallurgical group. Acceleration is a particularly handy tool to employ in the heating of thin-skinned ingots. The best treatment thin-skinned ingots can be given is to charge immediately, charge light, heat quickly and roll hot.

Acceleration is further hindered by short roll turns or as is often the case by too few roll turns. Speed is only of importance when it may be utilized. Consequently, our soaking pits have a much greater potential as far as output and acceleration are concerned. ▲

Application of Cushioning Material Under Crane Rails

by K. D. Cunningham, Assistant District Manager,
American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

Specially designed padding inserted under the rails of ore bridges reduces impact stresses by 30 per cent and prevents wearing of the girder flange surfaces into grooves, one cause of runway misalinement.

GENERALLY speaking, the design engineer calls for cushioning material under crane rails for one or all of the following reasons: (a) reducing impact shock, (b) reducing vibration and (c) reducing noise. However, many designs have called for a cushioning material under crane rails principally for protecting the top flange material of the crane girders from the wear and grooving action of the crane rail as it moves in either a longitudinal or horizontal direction on the top flange of the girder as a result of starting, stopping and side thrust of the cranes.

It has been the experience of our inspection engineering group in the general maintaining of United States Steel Corp. mills in the Pittsburgh district (which also covers Johnstown, Pa., and Lorain, Ohio) that one of the most common ailments of existing crane runways is this top flange wear and groove. The action of the crane rail has worn this grooving, which can vary from a deep imprint to, in some cases, a groove completely through the first layer of girder top flange material. After the rail has seated itself in a groove such as this, a very unsatisfactory condition from the standpoint of crane runway alinement exists, and prevents shifting the rails horizontally to obtain the correct center-to-center distance.

Cranes located on runways which have had excessive settlement or wear of their crane girder connections usually have runways that are badly misalined and out of square with the crane end trucks. This lack of alinement can cause excessive wear on rails, wheels, bearings and generally give unsatisfactory and costly service from a maintenance standpoint. In remodeling and repairing an existing crane runway, one of the most costly items is the repair or the replacement of girder top flange material that has been badly grooved through this action of crane rails.

Many types of remedies have been tried for this grooving of top flange material. Such repairs vary from the placing of sheet metal shims of various thicknesses under the rail and the placing of wear plates, continuous or at close intervals, to the complete replacement of the top flange material.

The merits of all these repairs or replacements could be argued pro or con as to the actual value, cost-wise and material-wise, of each of them. However, they are all costly repairs. With the cost of making these various repairs or replacements plus the fact that most of these repairs have to be carried out with a minimum of outage time, designers were ready to look favorably on any scheme or method that could alleviate this troublesome problem. This is what prompted us to recommend cushioning material under crane girders in our designs over the past few years.

An investigation into the design drawings of the many crane runway structures of the past few years indicated that in every case when a cushioning pad was recommended, a scientifically designed and manufactured material, composed of layers of specially prepared, tightly twisted, closely woven, light weight cotton duck was used. Each layer is thoroughly impregnated with a special rubber compound. This compound is a high quality natural or neoprene rubber. The layers are built up to the required thickness and vulcanized together. It will withstand loads up to between 10,000 and 19,000 psi before breakdown, depending upon size and thickness of the pad. In general applications, compressive stresses should not exceed 1500 psi for a long life, freedom from set, and high factor of safety. This material is manufactured in a variety of standard thicknesses, from $\frac{1}{16}$ to 1 in. Maximum width that can be furnished is 4 ft. The maximum length is up to and including 50 ft in one piece.

In the placing of these pads under the rails of the crane runways studies have been made and investigations carried out as to the expansion, contraction and creep of this cushioning material. It has been our findings that the creep on pads under sustained compressive loads is less than 2 per cent for stress up to 2000 psi. This is much higher than the usual stress on cushioning material in a crane rail application. For example, an 86,000-lb wheel load on a 175-lb rail results in a stress of about 600 to 750 psi. This is assuming that the distance that a wheel load can be distributed by a rail to the top flange of a girder would be equal to about four times the depth of the rail. It is our opinion that this assumption of distribution is well on the conservative side. Although no definite figure for the coefficient of lineal expansion and contraction of any of these cushioning materials is available, the opinion that the allowances being used at the present time, $\frac{1}{2}$ in. per rail length when butting the ends of this material, is more than sufficient to cover this expansion and contraction.

Investigation of this padding revealed it was introduced into the industrial field in the year 1934 and has

many more applications than those related to crane runways.

As previously mentioned, molded fillers not only absorb the shock and vibration but eliminate cover plate wear. It is certainly cheaper to replace the molded filler even at $6.00 per sq ft than to rebuild the girder. For example, the price of padding per lineal foot for a 105-lb rail, which has a base of $5\frac{3}{16}$ in. wide and using an $\frac{11}{32}$-in. pad, is $3.98 per lineal ft. This does not include erection. A question arose as to why the thickness of $\frac{11}{32}$ in. was used in every case. The reason for using the $\frac{11}{32}$ in. thickness is covered by the Government Bureau of Reclamation Impact Stress Report. It shows that $\frac{11}{32}$-in. thick padding reduces impact stress to the structure by 30 per cent, and a $\frac{5}{8}$-in. thick padding reduces the impact stress by 40 per cent. If the $\frac{5}{8}$-in. thick paddings were used, the increased cost would not be justified by only a 10 per cent increased reduction in the impact stresses.

It has been our experience that more satisfactory results are obtained by erecting this material in maximum 50-ft lengths. The weight for a running foot of this pad, $5\frac{3}{16}$ x $\frac{11}{32}$ in. thick, is $\frac{9}{10}$ lb per ft. Therefore, the 50-ft roll would only weigh approximately 45 lb, which can be very readily handled in the field.

After several unsuccessful repairs using a natural rubber compound, it has been concluded that this cushioning material should be compounded with neoprene rather than compounded with natural rubber. A few of the reasons for this are that neoprene is oil resistant and it will stand 50 F more continuous heat. Neoprene on overhead crane structures can be subjected to 200 F, whereas natural rubber would only stand 150 F without relatively rapid deterioration.

Some mention should be made concerning the effectiveness of a fabric cushioning material in absorbing impact loads. Impact loads can be applied to crane runways in a variety of ways, abrupt starting or stopping of crane bridge or trolley and, one of the most common, faulty rail joints on the crane runway itself. Extensometer tests made in the field at one of the U. S. Steel mills have proved that a bad rail joint or a broken rail can increase the stress, due to impact from pounding, on the supporting girder as much as 70 or 80 per cent in the area of this broken rail. A cushioning material under a broken rail is not a cure-all for this condition, but it can be proved that the over-all cushioning effect of the padding is a definite asset to any runway in the absorption of impact loads.

The Government Bureau of Reclamation has made various tests along this line. These government tests show that the reactive force exerted by an elastic body when a weight is dropped on it from any height is:

$$F = W + \sqrt{W^2 + 2hkW} \qquad (1)$$

where:

F = the reactive force
W = the weight dropped
h = height of drop
k = spring constant of the elastic body

When no energy is involved in the application of such a load, i.e., h = 0, Equation 1 reduces to the familiar relation for the force exerted by suddenly applied load.

$$F = 2W \qquad (2)$$

This shows the theory would be in agreement with the experimental results from the government tests since, when h = 0, the force is independent of the elastic properties of the body. The loading mechanism used in the test simulates the actual field condition of a load applied to a crane rail through the framework of the crane. It was proved that pads are effective in reducing the impact load because of their low modulus of elasticity or, what is the same thing, their low spring constant. In fact, for impact loads where the energy component is predominant, this reduction theoretically approaches the value of $\sqrt{k_f}/k_s$, where k_s = the effective spring constant of the entire structure from the point of application of the load to the crane girder with no pads; k_f = the corresponding value with pads included.

Actual evaluation of this factor is difficult for even as simple a structure as the test loading mechanism. It would, of course, be considerably more difficult for a complex prototype structure such as a crane. However, the results of the government tests indicate that the use of fabric pad for the reduction of stress due to impact loads is effective when there is an energy component to the load. Under the test conditions, average reductions of approximately 30 and 40 per cent were observed. As a result of these tests, the decision to use the $\frac{11}{32}$-in. thick pad, previously mentioned, was arrived at.

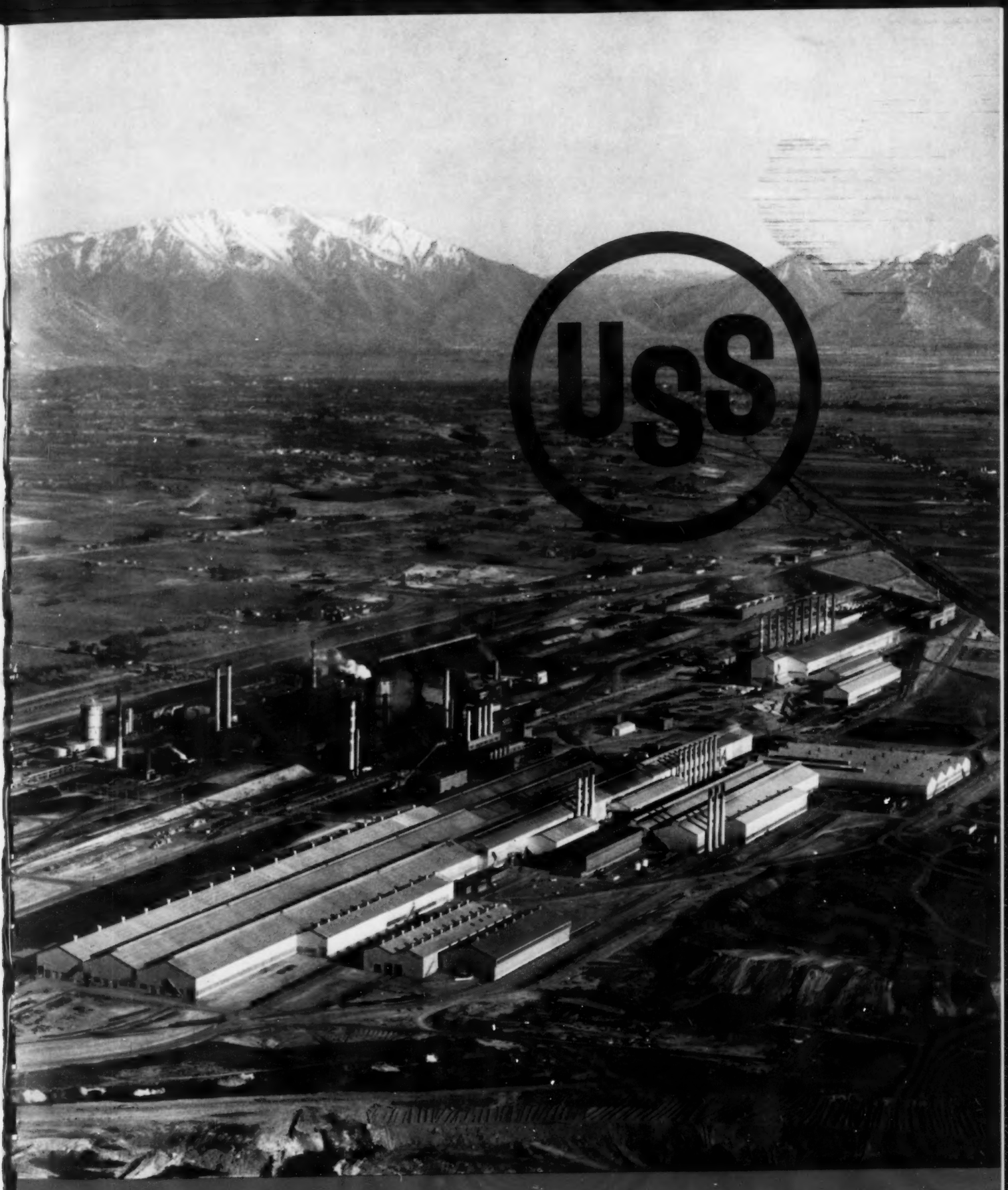
On ore bridges, cushioning material on the trolley rails as well as on the main overhead traveling rails is being used because it reduces the impact stress of the bridge structure from sudden movements of loads, reduces the mechanical wear of the supporting surfaces of the trolley rails, reduces the shock to the cab and operator, and makes for a quieter operation. The fact that noise is reduced is an indication that vibration to the whole bridge has been reduced.

In some designs, compounded fabric washers backed up by steel washers at the clip bolts are used to relieve bolt stress and also to act as a lock washer. When a wheel load is applied to the rail, the pad beneath the rail deflects a few thousandths of an inch and the clip bolt washer expands thus keeping the bolt tension. When this wheel load is removed, the pad beneath the rail, being of greater area than the washer, would again compress the washer and retain the bolt tension. This is because of the pad's lack of permanent set. Where resilient clip bolt washers are used, there is a considerable reduction in broken clip bolts.

SUMMARY

The effects of padding beneath crane and ore bridge rails are as follows:

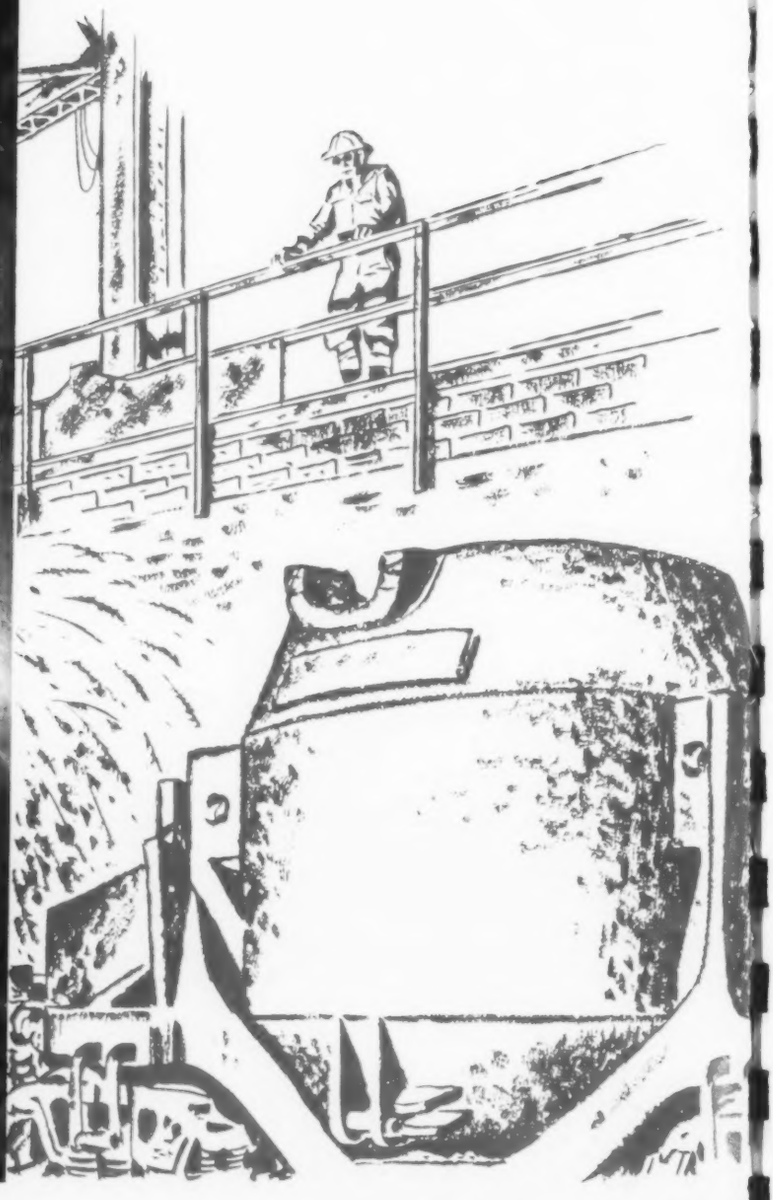
1. Padding reduces wear to the girder or cover plate.
2. Padding $\frac{11}{32}$ in. thick reduces impact stresses by 30 per cent to the structure as pointed out by government test reports.
3. Padding affords a slight amount of resilience to the rail, compensating for some of the skew of the bridge or carriage.
4. Padding reduces vibration and resultant mechanical wear such as loose rivets, etc.
5. Padding prolongs rail life.
6. Resilient washers materially reduce the number of broken clip bolts. ▲



UNITED STATES STEEL'S GENEVA WORKS

UNITED STATES ST

by T. J. Ess



ES STEEL'S GENEVA WORKS

JUST two years after Brigham Young and his followers settled in Salt Lake Valley, deposits of iron ore were discovered in Iron County, some 300 miles south of Salt Lake City. Settlers soon located in that area and in 1852 a blast furnace at what is now Cedar City began producing pig iron. This furnace was purchased and enlarged by the Deseret Iron Co., but the operation proved uneconomical and was stopped in 1858.

Another early venture was the Great Western Iron Manufacturing Co. established in 1868. Between 1873 and 1883, this company produced about 2400 lb of pig iron per day, which was cast into stoves, pots and pans, etc. This enterprise was not financially successful and ceased operations in 1883.

Still another unsuccessful project was the Ogden Iron Manufacturing Co., which lasted only two years (1882–1884) and produced only 57 tons of iron.

In 1915 the Utah Iron and Steel Co. was organized (incorporated as Utah Steel Corp. in 1919) and first produced open hearth steel in 1917 at Midvale, just south of Salt Lake City. This plant was closed permanently following World War I.

Pig iron production in Utah was resumed in 1924 when a 450-ton blast furnace was blown in at the Ironton plant of Columbia Steel Corp. This furnace had a 15 ft, 9 in. hearth. A by-product coke plant produced coke from Utah coals for use in the furnace. This venture proved successful and operations have continued to the present day. In 1930, Columbia was acquired by United States Steel Corp. In 1943 a second blast furnace was constructed here. The Ironton plant is located seven miles south of Geneva Works.

In 1941, with war in Europe and world conditions worsening, the Defense Plant Corp., an instrumentality of the United States Government, called upon Columbia

L. J. WESTHAVER
Executive Vice President

J. D. McCALL
Vice President—Operations

LESLIE B. WORTHINGTON
President

LAWRENCE F. BLACK
Manager of Utah Operations

CHARLES C. MORGAN
General Superintendent
Geneva Works

CARL J. FORKUM
Assistant General Superintendent
Geneva Works

Steel Corp. to assist in designing and constructing an integrated steel plant in Utah for the Defense Plant Corp.

After thorough investigation, a site was chosen on the east shore of Utah Lake, about eight miles northwest of Provo and about 35 miles south of Salt Lake City. This site is roughly triangular in shape and covers 1502 acres. The Union Pacific Railroad runs along the east side of the property and the Denver and Rio Grande runs through it. Important factors in the site selection were its sheltered location 600 miles inland from the Pacific and its access to raw materials hitherto little used.

The original plant was projected with annual capacities of 1,150,000 tons of iron and 1,283,400 tons of ingots. Rolled products were set at 700,000 tons per year of plate and 200,000 tons per year of structural shapes, billets and bars. These were intended principally for ship building on the West Coast.

The original plant included 252 by-product coke ovens, three 1100-ton blast furnaces, nine 225-ton open hearth furnaces, a 45-in. slabbing-blooming mill, a 132-in. semi-continuous plate mill, a 26-in. structural mill and the essential auxiliary facilities.

Ground was first broken for the plant on March 27, 1942. Coke production began on December 14, 1943, the first blast furnace was blown in on January 3, 1944, and steel was poured on January 17, 1944.

When the plant was completed, it was operated for the

Desert Mound mine is one of the two major open pit mines owned by Columbia Iron Mining Co. This mine and its sister operation, Iron Mountain mine, supply most of the iron ore for Geneva Works.

government on a nonprofit agreement by Geneva Steel Co., a newly-formed subsidiary of U. S. Steel. With the end of World War II, operations of the Geneva plant eventually ended. Early in 1946, the War Assets Administration accepted U. S. Steel's bid and the Geneva plant became the property of U. S. Steel. It is now a unit of the corporation's Columbia-Geneva Division.

A program was immediately begun to convert the plant to serve the peace-time economy of the West. This involved the addition of finishing stands and coilers to the 132-in. plate mill and the installation of auxiliary equipment. Since that time various projects and additions have increased the capacity of the Geneva plant. The plant today has the following rated capacities:

	Tons per year
Coke	1,094,500
Iron	1,321,500
Steel	2,300,000

In addition, Ironton has annual capacities of 251,200 tons of furnace coke and 482,700 tons of iron.

A central coal cleaning plant near Wellington, Utah, conditions coal for coking. Fine coal is separated from rock and pyrites on these concentrating tables.

RAW MATERIALS

Almost all of Geneva's raw materials come from the state of Utah at not too great a distance from the plant.

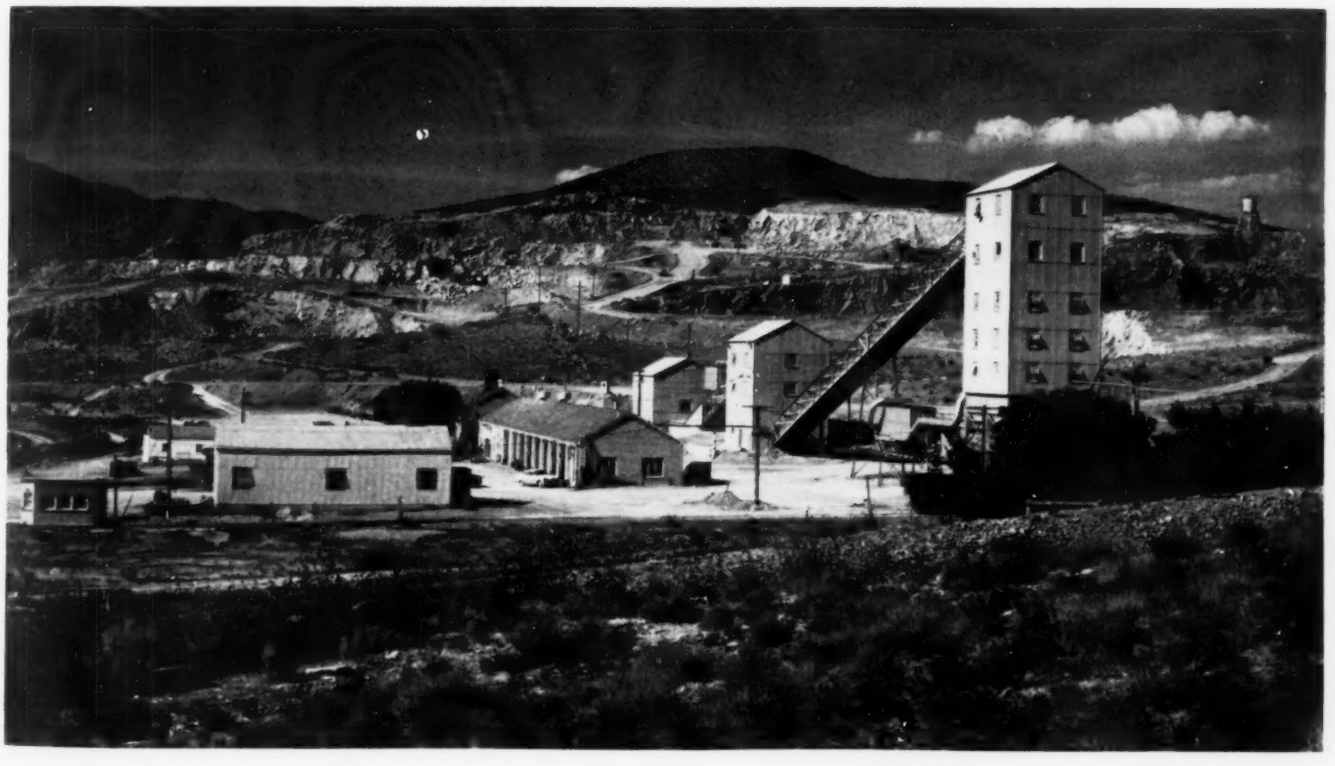
The company's iron ore comes principally from two separate mining areas (one at Desert Mound, one at Iron Mountain) near Cedar City, in the southwest section of Utah, and about 250 miles south of the Geneva plant. These mines are operated by Columbia Iron Mining Co., a U. S. Steel subsidiary. At both mines, the surface covering is stripped off and the ore mined by open pit methods. Rotary drills and blasting loosen the ore, which is then loaded by 4½-cu yd electric shovels into 30-ton trucks. The trucks unload at a crushing station where the ore is crushed and screened to pass through a 3-in. to 4-in. screen. The ore is then loaded into railroad cars for shipment to Geneva and Ironton.

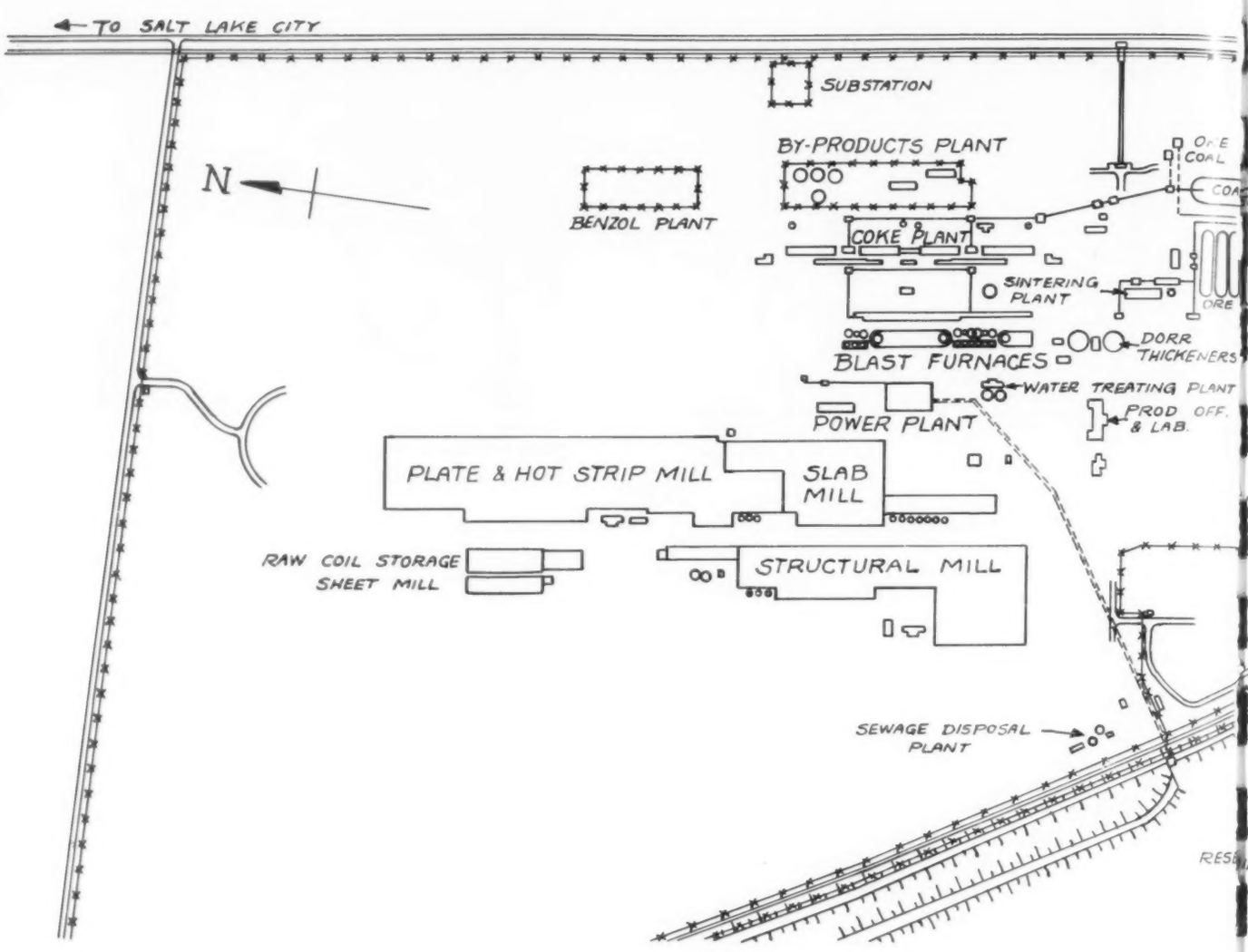
To supplement production from Columbia Iron Mining Co., Geneva Works purchases some iron ore, including some low grade manganese ore. The latter is added to the furnace burden. It generally contains less than 40 per cent manganese and forms about 5 per cent of the burden.

At present two pits are being worked at Desert Mound and three at Iron Mountain. The pits are worked in 35-ft benches with working faces 100 to 200 ft long.

The ores are hard and rather uniform in iron content, but vary considerably in content of impurities and in the proportions of hematite and magnetite. This is evened

Limestone for Geneva Works comes from Keigley quarry near Payson, Utah, some 35 miles from the plant.





out by mixing several ore faces at the mines and by a bedding system at the steel plant.

Coal comes principally from two company-owned mines located respectively at Columbia and Horse Canyon, approximately 130 miles from Geneva. Both mines take coal from the Sunnyside seam, which is 11 to 16 ft thick. Columbia mine can produce about 2800 tons per day and the Geneva mine at Horse Canyon, about 4500 tons per day. Some high volatile coal also comes from a company-owned mine in Colorado.

These coals are not exactly top-flight coking coals by normal metallurgical standards, but over the years, experimental work at Ironton and Geneva has evolved methods by which satisfactory blast furnace coke can be produced. Coal from the Sunnyside seam is customarily mixed with low volatile purchased coals from Oklahoma and Arkansas.

A coal washer was recently installed at Wellington to which all high volatile coal is brought. Incoming raw coals are blended in definite proportions before being washed. Coarse coal and fines are washed separately. Coarse coal is then crushed to 1½ in. and recombined with the washed fines. The plant is designed for 600 tons of raw coal per hour, the total output being shipped by rail to Geneva and Ironton.

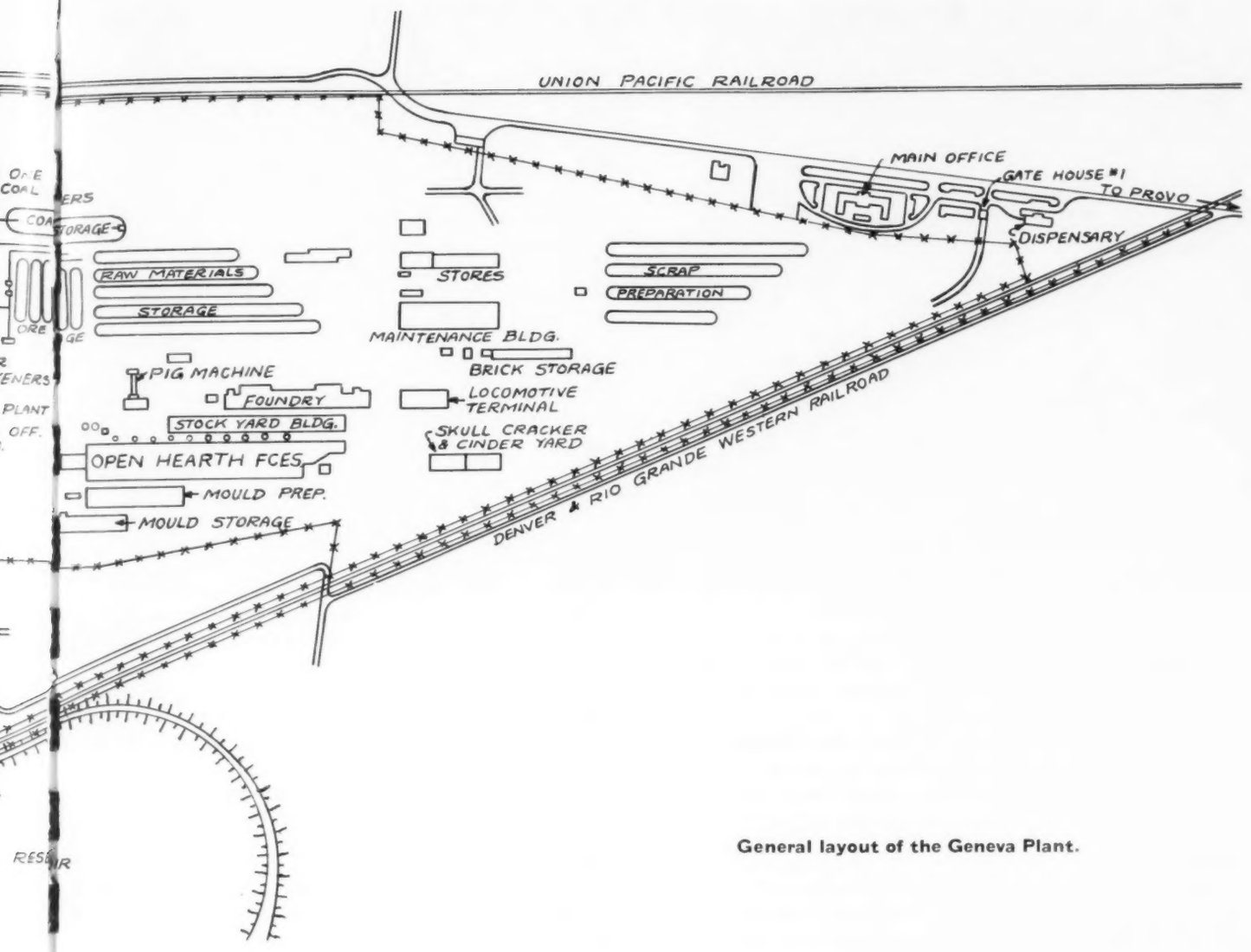
Metallurgical limestone comes from Keigley quarry near Payson, about 27 miles south of the Geneva plant. This quarry has several strata of stone with varying amounts of magnesia, silica and lime. Fairly uniform stone is obtained by blending the materials from several faces of the quarry.

Stone is crushed at the quarry and screened according to its end use. For the blast furnaces, high calcium stone is sized to minus 2½ in. x plus ⅝ in. and 3/16 in. x 0. For open hearth use, high calcium stone is sized to minus 9 in. x plus 2½ in. Stone is shipped to the plants by rail.

COKE PLANT

G. WILLIS MADSEN
Division Superintendent—
Coke & Coal Chemicals

Upon arriving at the Geneva plant, coal cars are shifted by an electric mule to a rotary car dumper which dumps the coal into a double track hopper. From the hopper, coal is fed by vibrating feeders onto a conveyor belt leading to a junction house, from where it



General layout of the Geneva Plant.

may proceed either to storage or to the crusher building.

Coal going to storage is carried by belt conveyor into an elevated gallery extending the length of the storage space, which is approximately 1000 ft long x 150 ft wide and under plant operating procedures has a storage capacity of 90,000 to 120,000 tons of coal. One motor-operated and one belt-operated tripper which travel the length of the gallery dump the coal at any desired point.

Below the base of the storage yard is a concrete tunnel housing a reclaiming feeder and conveyor system. When coal is to be taken from storage, the feeder, with receiving hopper, conveyor belt and discharge chute, is moved to one of the openings in the tunnel roof, and the gates opened. Coal then passes over the feeder conveyor and onto the main conveyor which carries the coal to the crusher building.

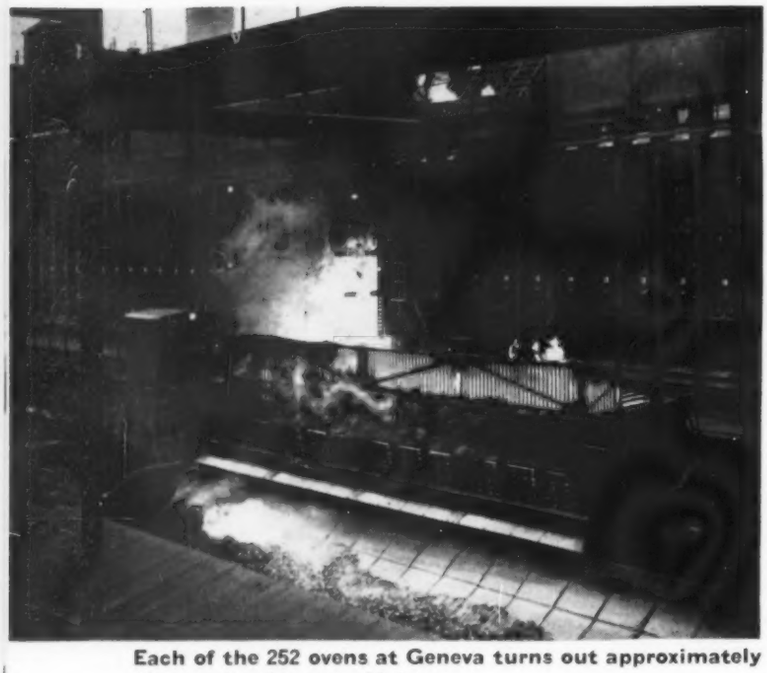
In the crusher building coal is discharged into a hopper and then passes over a $\frac{5}{8}$-in. stationary bar grizzly screen. Larger sizes pass over the screen, through two 350-ton per hr hammer mills and then joins with undersized coal from the bar grizzly. The mixture is then conveyed to the mixing and storage building.

The mixing and storage building contains four 400-ton storage bins, into which coal may be discharged as desired through a revolving chute operated from the mixing floor by a hand wheel. Coal may be drawn from the hopper bottom of each of these four bins in the proportions desired, and passes through another pair of hammer mills (350 tons per hr each), and over conveyors to a junction house on the way to the oven storage bins. The coal is pulverized so that 70 to 80 per cent will pass through a $\frac{1}{8}$-in. screen. From the junction house coal may be directed either to the storage bins for No. 1 and 2 batteries or to the bins for No. 3 and 4 batteries, as desired.

Each oven storage bin, with its capacity of 2000 tons of coal, thus serves two batteries of ovens. The bins are divided into four sections of three cells, serving the three hoppers of the gantry type larry cars which operate on top of each battery and which carry a definite measured quantity of coal to each individual oven as needed.

The coal charged to the ovens normally consists of 76 per cent high volatile coal, 12 per cent medium volatile coal and 12 per cent low volatile coal. The mixture's analysis averages 35.99 volatile matter, 58.30 per cent fixed carbon, 5.71 per cent ash, 0.73 per cent sulphur and 7.54 per cent moisture.

The coke ovens, arranged in four batteries of 63 ovens each, are of the low differential, combination underjet type, 43 ft-2½ in. long x 13 to 15½ in. wide x



Each of the 252 ovens at Geneva turns out approximately 10 tons of coke every 16.4 hr.

13 ft high, each taking a normal charge of 14.4 tons of coal. Gross coking time averages 16.8 hr, so that the entire installation has a coking capacity of 5200 net tons of coal per day.

In two of the batteries, the ovens are heated by straight coke oven gas, while the other two batteries are arranged for heating with either blast furnace or coke oven gas.

A pressure of 5 mm is maintained in the collecting mains by an automatic pressure regulator.

When coking is completed, the coke from each oven is pushed individually into a side-dump hopper car, carried to the quenching station where it is watered until quenched, and then dumped upon brick-paved coke wharves. Flow of coke from the wharves to the conveyors is controlled by manually operated cut-off gates.

Conveyed to the screening station, the coke passes over a 1-in. square mesh plate screen. All coke passing over this screen is carried by belt conveyors to the blast furnace stock bins. Coke passing through the screen is conveyed to a domestic screening station where it may be segregated into the various sizes as desired. From the domestic screening station, coke goes into elevated storage bins for gravity feed into railroad cars.

Furnace coke usually runs about 63.6 per cent of the coal weight, with smaller sized coke totaling about 4.07 per cent.

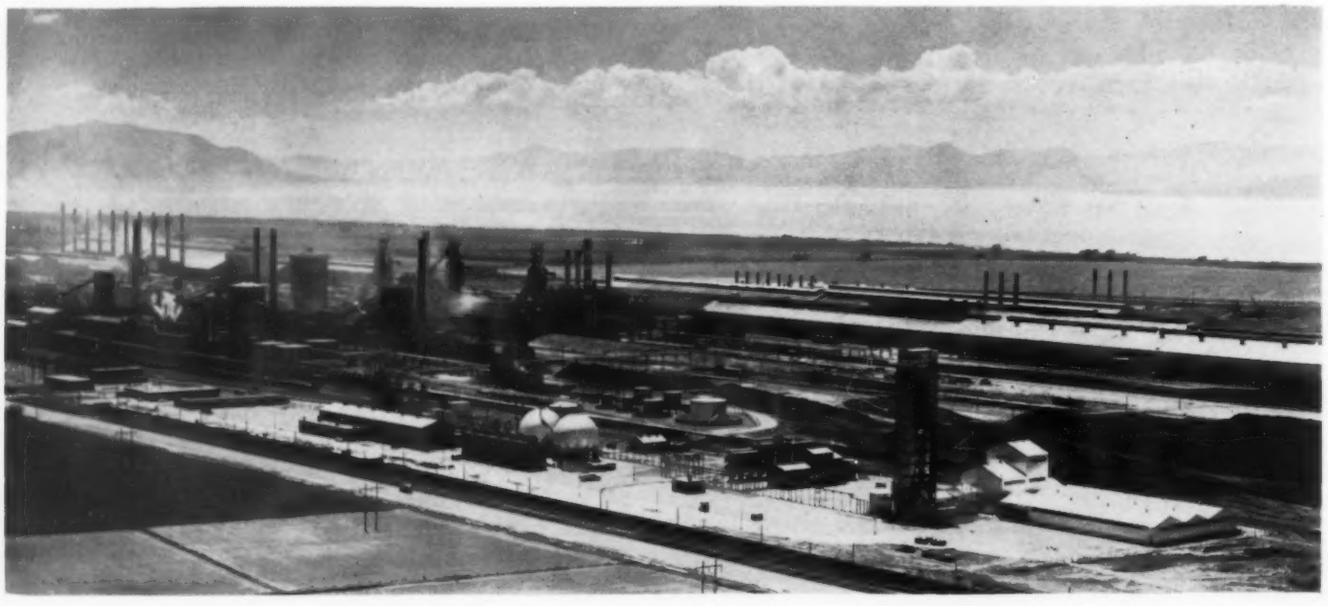
When the Geneva plant began operations, coke quality left much to be desired. Many tests were run to increase bulk density of the coal charged to the ovens and to improve coking practices generally. Out of this came a change in coal pulverization practice, an increase of about 100 degrees in coking temperature and the addition of two to four per cent of pitch to the coal charge. This resulted in a denser coke, a higher furnace coke yield and a lower coke rate in the blast furnaces. Subsequent experimentation has eliminated the need for pitch. Work is currently under way to further improve coal sizing.

The by-product plant follows the conventional design for the recovery of tar, ammonia, naphthalene and light oils. Gas comes through two 54-in. mains to direct type primary coolers with wooden hurdles. The gas is cooled by sprays of ammonia liquor which is then cooled and recirculated. The gas then passes through turbine-driven exhausters and through electrostatic precipitators to remove residual tar.

Gas is then passed through the saturators, which contain a weak solution of sulphuric acid, to remove all ammonia from the gas and form ammonium sulphate, which is produced in granulated form. Next, the gas passes through final coolers of direct water spray type. This cooling causes condensation of considerable naphthalene, which is removed by circulating tar in the lower section of the coolers.

To recover the light oil, the gas is put through scrubbing towers packed with small steel spiral filling. Wash

This general view shows the nitrogen plant in the foreground. This facility can produce ammonia, nitric acid and ammonium nitrate.



This view shows the storage and bedding area at Geneva. Coal is stored in the pile running across the foreground. Iron ore is bedded in the piles immediately above.

oil sprayed in at the top of the scrubbers absorbs light oils from the upflowing gas. Following this, the gas goes to a 500,000-cu ft waterless type gas holder.

A recent addition is a nitrogen products plant designed to produce commercial nitrogen fertilizers, nitric acid, etc. Briefly, hydrogen is stripped from coke oven gas and combined with nitrogen from the air to form anhydrous ammonia. Some of this product is used to make nitric acid. Some liquid ammonia is combined with nitric acid to produce ammonium nitrate.

This brief description over-simplifies the nitrogen products unit, which is actually a large, complicated chemical plant requiring sensitive instruments and accurate controls to regulate the various processes.

The nitrogen products plant is the first of its kind in the United States, which is associated with a steel manufacturing facility, although the basic processes have been used in Europe for more than 30 years.

With some of the oven heating done by blast furnace gas, only about 25 per cent of the coke gas make is used by the ovens. Surplus gas is boosted to 5-psi pressure and distributed to the rolling mill furnaces, open hearth and boiler house. This system uses approximately 1,300,000,000 cu ft per month. At the coke plant natural gas may be mixed with sufficient air to equal the calorific value of coke oven gas and fed into the coke gas system if the supply of coke gas is insufficient to meet the demands of consuming departments.

The benzolized wash oil from the scrubbers is heated and put through the wash oil still, where it flows down over 13 trays. Steam rising in the still heats the oil to a point where the light oil is vaporized and passes from the top of the still. Primary light oil is condensed in a vapor-to-oil heat exchanger and is returned to the wash oil still. Vapors not condensed flow to a light oil rectifier column, where intermediate and secondary light oils are obtained.

Next, the intermediate and secondary oils are separated into their respective fractions, obtaining naphthalene, benzene, xylene, solvent naphtha and toluene. This is done in a crude still, a crude rectifying column, a carbon-disulphide rectifying column, a motor-fuel rectifying column, a pure still and a pure rectifying column, plus numerous heat exchangers, washers, etc.

BLAST FURNACES

L. TOFFT
Division Superintendent—
Blast Furnaces

When iron ore arrives at the blast furnaces, the railroad cars are unloaded by a rotary dumper and carried by underground conveyor belt to a bedding area. Here a cross conveyor runs across one end of the ore piles and can feed ore to any one of four stacker conveyors running between the eight ore beds. Each bed will accommodate about 12,000 tons of ore. A double-wing stacker with two boom conveyors places many thin layers, one over the other to form ore piles triangular in section.

Ore is reclaimed from the beds at a rate of 400 tons per hr by two machines that take an almost vertical cut from the beds and deposit the ore on conveyors which transport it to a screening station. Here four double-deck vibrating screens size the ore, with all minus ¼-in. material going by belt conveyor to the sintering plant. Ore for the furnaces is moved by conveyor to bins near the high line, from where a 120-ton transfer car carries it to the stock bins.

Storage for an additional 600,000 tons of ore is provided by a nearby area with railroad tracks laid out so

The three blast furnaces at Geneva have 25-ft hearths and provide capacity for the production of 1,321,500 tons of iron per year.

that boom cranes with clam shell buckets can unload and load ore cars. Ore reclaimed from this storage is then put through the bedding system.

Metallurgical limestone for the blast furnaces arrives in hopper cars which are dumped directly into the stock bins. The minus $\frac{3}{16}$-in. stone is handled with the blast furnace ore through the bedding system. Some stone is also piled as an emergency standby.

Coke is brought by belt conveyors from the coke screening station to the 170-ton coke bins at each furnace. As coke is drawn from these bins, it passes over a $\frac{3}{4}$-in. vibrating screen before falling into a skip bucket. Coke is charged by weight.

The blast furnace high line has 53 stock bins of reinforced concrete construction, providing capacity for about 5000 tons of iron ore and sinter, 900 tons of limestone, and some miscellaneous materials. It is topped by two railroad tracks, one of which is used by the transfer cars. Under the stock bins, 25-ton scale cars move ore and stone from the stock bins to the skip buckets.

Each furnace is charged by a double skip with two 250-cu ft buckets, operated at speeds up to 360 fpm by a single-drum hoist with dual drive. A revolving distributor top is provided for each furnace. Furnace bells are operated by pneumatic cylinder hoists, using cold blast from the furnace blowers.

The skip hoist, distributor and bells are under an automatic control system which sequences all charging operations.

The normal charging sequence is OSC/OCC. A typical round consists of 40,000 lb of ore, 1800 lb of limestone, 1800 lb of dolomite and 16,800 lb of coke. About 40 per cent of the ore charge is sintered.

The three blast furnaces were originally constructed as duplicates. In the most recent relining of No. 1 furnace, some slight changes were made. Furnace dimensions and other pertinent data are given in Table I.

The total height of these furnaces, 93 ft from iron notch to top ring, was made somewhat less than in eastern furnaces because of the comparative weakness of coke made from Utah coals.

The hearth jacket, made of welded steel plate $1\frac{1}{2}$ in. thick, is 15 ft-3 in. deep x 33 ft-6 in. in diameter. Reinforcing plates are provided at the iron and cinder notches. Hearth cooling plates are 5 in. thick, 15 ft-9 in. deep and 32 ft-6 in. in diameter, and are provided with $1\frac{1}{2}$-in. pipe cast integrally.

The tuyere jacket, supporting 18 tuyere cooler holders equally spaced around the diameter and two cinder notches, is 29 ft-6 in. in diameter and 6 ft-9 in. deep, fabricated of $1\frac{1}{2}$-in. steel plate. There are four bosh bands of $1\frac{1}{2}$-in. welded steel plate, two of them 12 in. wide, one 15 in. wide and one 24 in. wide.

The mantle, of welded steel construction with $1\frac{1}{2}$-in. web and flange plates, and $1\frac{1}{4}$-in. breast plates is supported by nine columns fabricated from rolled steel and protected by cast iron guards.

The furnace shell is also of welded steel construction, 73 ft-6 in. high. A steel casting, made in two sections flanged and bolted together, forms the furnace top ring.

Four cast steel segments make up the large bell hopper, while welded steel plate $\frac{5}{8}$ in. thick form the gas seal.

Furnace hearths are constructed of ten courses (15 ft) of 18-in. x 9-in. x $4\frac{1}{2}$-in. high duty and cone 23 refractory blocks on top of the concrete foundation pad. The blocks are laid in herringbone solider courses, each course rotated 45 degrees, with the top course joints at 45 degrees to the center line of the iron notch.

Cooling plates are carried up through the bosh and ten rows up into the inwall section. In the stockline section, 16 rows of steel wearing plates furnish protection against erosion.

The furnace is blown through 18 tuyeres fed through 7-in. blowpipes from a bustle pipe. An I-beam runway attached to the under side of the bustle pipe carries a two-ton manually operated trolley and hoist for use in maintenance work.

Stoves are of two-pass, side-combustion design. Each stove contains 23,386 cu ft of checker space. Gas is burned in the stoves through pressure burners which automatically maintain the desired gas-air ratio. Gas consumption usually ranges 12,000 to 13,500 cfm per stove. Dome temperatures are automatically limited to 2050 F. Natural draft for the stoves is provided by a reinforced concrete stack 225 ft high x 14 ft top diameter.

Stoves are normally on blast for $2\frac{1}{2}$ hr and on heat about 3 hr or until their stack temperatures reach a maximum of 400 F. The stoves use 28 per cent of the gas. Surplus gas goes to boilers and to the coke ovens—about 60 per cent and 10 per cent, respectively, of the total gas made. A 1,000,000-cu ft gas holder is installed,

TABLE I
Blast Furnace Data

	Geneva			Ironton	
Furnace No.	1	2	3	1	2
Diameter of hearth, ft-in.	25-0	25-0	25-0	15-9	22-0
Diameter of bosh, ft-in.	27-11	27-2	27-2	19-6	24-0
Diameter of stockline, ft-in.	19-6	19-6	19-6	14-6	18-0
Height, iron notch to top ring, ft-in.	93-0	93-0	93-0	84-3	105-9 3/8
Height of crucible, ft-in.	10-6	10-6	10-6	8-6	12-0
Height of bosh, ft-in.	10-9	8-0	8-0	11-9	8-6
Height of straight section, ft-in.	3-3	6-0	6-0	6-0	4-0
Height of inwall section, ft-in.	48-6	48-6	48-6	40-0	48-0
Height of stockline section, ft-in.	6-5 11/16	6-5 11/16	6-5 11/16	9-11 5/8	11-7 1/8
Height, bottom to iron notch, ft-in.	2-0	2-0	2-0	1-3	1-6
Height, iron notch to cinder notch, ft-in.	4-2	4-2	4-2	4-0	4-8
Height, cinder notch to tuyeres, ft-in.	4-4	4-4	4-4	3-0	3-10
Working volume, cu ft	32,081	30,759	30,759	15,120	23,586
Bosh angle, deg-min-sec	82-17-17	82-17-17	82-17-17	80-56-0	81-52-12
Inwall slope, in. per ft.	0.9484	0.9484	0.9484	0.75	0.8125
No. of columns	9	9	9	8	8
No. of tuyeres	18	18	18	8	12
Tuyere diameter, in.	6	6	6	7	7
Big bell diameter, ft-in.	15-1	14-6	14-6	9-9	13-0
Big bell angle, deg	53	53	53	53	53
Lining thickness, crucible, in.	45	45	45	36	40 1/2
Lining thickness, bosh, in.	27	27	27	27	27
Lining thickness, inwall, in.	36	40 1/2	40 1/2	36	49 1/2
Lining thickness, stockline, in.	39 1/2	39 1/2	39 1/2	36	37 1/2
No. of offtakes	4	4	4	4	4
Offtake diameter, ft-in.	5-0	5-0	5-0	3-0	3-7
No. of stoves	3	3	3	4	4
Stove diameter, ft-in.	25-2	25-2	25-2	29-0	22-0
Stove height, ft	110	110	110	85	109
Checker openings, in.	2	2	2	4	4
Heating surface per stove, sq ft	208,035	208,035	208,035	50,214	87,152
Blast volume, cfm, average	67,624	67,624	67,624	34,012	42,800
Blast temperature, F, average	1203	1203	1203	1175	1175
Blast pressure at tuyeres, psi, average	21.5	21.5	21.5	21.5	21.5
Lb of ore and sinter per ton of iron	3760	3760	3760	4128	3781
Lb stone per ton of iron	295	295	295	481	505
Lb of coke per ton of iron	1455	1468	1468	1591	1591
Lb of scrap charged per ton of iron	39	39	39	...	...
Lb of roll scale per ton of iron	35	35	35	...	299
Lb of flue dust charged per ton of iron	...	...	...	...	...
Daily hot metal production, net tons	1315	1304	1304	601	757
Lb of slag per ton of iron	991	991	991	1117	968
Lb of flue dust generated per ton of iron	170	170	170	310	265
Ratio of stone to mix, per cent	5.3	5.3	5.3	7.8	8.6
Fuel ratio, Fe:Coke	1.29	1.29	1.29	1.19	1.19

sufficient to tide the ovens over short interruptions in blast furnace gas supply.

These stoves, equipped with an automatically controlled mixing valve, are capable of maintaining a straight line blast temperature of 1500 F. The trend is toward higher blast temperatures, which often approach 1550 F.

Air for blowing the three furnaces is provided by four five-stage, uncooled centrifugal blowers, each having a maximum capacity of 95,000 cfm at 35-psi pressure. Each blower is driven by a 12-stage, 450-psi, 11,350-hp condensing steam turbine. Normal steam consumption is about 42,000 lb per hr. The blowers are provided with a constant volume regulator taking its initial impulse from a venturi throat in the intake stack. Air discharge piping is arranged so that any one of the three blast furnaces can be blown by any one of the four blowers. The blowers are located in the power house.

Gas leaves the top of the furnace through four offtakes which combine into two 7-ft uptakes and then into a single 11-ft downcomer. Offtakes and uptakes are all lined with 4½ in. of firebrick. Top temperature averages 280 to 290 F, top pressures 1.2 to 1.4 psi.

Gas cleaning equipment includes a dust catcher, primary washer and electrical precipitator for each furnace. The dust catcher, 35 ft in diameter x 36 ft high between bend lines, has a cone-shaped entrance passage reaching almost to the bottom of the dust catcher. The bottom of the dust catcher is provided with the necessary valves and spouts for discharging to a pug mill or to railroad cars.

Leaving the dust catcher with a dust content of about 1.6 grains per cu ft, the gas enters a primary washer of conventional wooden hurdle type, with a cyclone unit superimposed, where the dust content is further reduced to about 0.15 grain per cu ft.

Final cleaning is effected in an electrical precipitator with a normal rating of 110,000 cfm. Each precipitator contains 260 tubes, 12 in. in diameter x 15 ft long, and operates on 75,000 volts provided by a high tension transformer and mechanical rectifier. All gas is thus cleaned to a dust content of about 0.008 grain per cu ft.

The dirt-laden water from the gas washers, amounting to about 9000 gpm, passes to a pump which lifts the water into two 110-ft diameter thickener basins. The sludge which settles to the bottom is raked to the center of the basins, where it is picked up by diaphragm type sludge pumps and pumped to one of three settling ponds. After drying, it is trucked to the ore beds.

There are two sintering machines of the continuous

pallet type, 72 in. x 102 ft, each with an annual capacity of 450,000 net tons of sinter. Each machine has 16 wind boxes. Fine ore and coke breeze are taken from storage silos and mixed in a hopper which discharges through vibrating feeders into a revolving drum pug mill. A considerable amount of limestone is also in the mixture because of the limestone fines put through the ore bedding system. The pugged mixture is then carried to a feed hopper which discharges through a swinging spout onto the sintering machine.

At the discharge end of the sintering machine, the sinter passes over a 1-in. bar grizzly, is sprayed with water, and conveyed to a hopper located on the blast furnace high line. A transfer car moves the sinter to the blast furnace stock bins.

An electrostatic precipitator on the sinter plant stacks reduces dust and heavy fumes before the gases are discharged.

The furnaces are cast every 4¾ hr into open-top ladles of 70 tons capacity. Analyses of the basic iron produced are about as follows:

	Per cent
Silicon	0.80–1.20
Sulphur	0.035–0.045
Phosphorus	0.46
Manganese	0.1–0.17

The ladles may then proceed to the open hearth, to the foundry or to the pig machine, as needed.

The pig machine is a double strand, about 170 ft long, which forms pigs 30 to 40 lb in weight. Pigs are cooled by water sprays and chuted from the end of the machine into railroad cars.

Slag analyses run:

	Per cent
SiO_2	37.2–37.5
Al_2O_3	13.7–13.8
CaO	31.6–32.6
MgO	12.5–13.4
S	1.05– 1.09
Fe	0.23
Mn	0.11– 0.12

Slag is run into 400-cu ft ladles and hauled to a dump.

Ten open hearth furnaces, each rated at 315 tons, produce heats in about 10 hours. Steelmaking capacity totals 2,300,000 tons per year.

MOLD FOUNDRY

Because of the remote location of the plant, and for convenience and cost considerations, a foundry was built at Geneva for casting ingot molds and stools, as well as gray iron castings for plant use.

The foundry is located near the open hearth stockyard. It has a main aisle, 850 ft x 78 ft, a parallel cupola aisle 200 ft long and another aisle 350 ft long for sand handling. Originally, three 60-in. x 70-ft cupolas were installed here, but these have been removed, and all castings are made from hot metal from the blast furnaces. This arrives in 70-ton open top ladles from Geneva furnaces or in 150-ton mixer type ladles from Ironton and is reladled into 30-ton bottom-pour ladles.

The foundry contains complete facilities for the preparation and drying of molds and cores. Permanent metal molds are used in casting stools.

OPEN HEARTH

E. W. HUNZIKER
Division Superintendent—
Open Hearth & Foundry

The open hearth facilities are housed in seven principal building aisles, as listed in Table II. Along the west side of the stock yard are elevated bins for ferro alloys, limestone, dolomite and iron ore. These materials are unloaded from railroad cars on a track above the bins and are withdrawn from the bins as needed into charging boxes or other containers at ground level.

The leanto, with three interconnecting tracks, is used primarily for stock assembly. It also houses the control rooms for furnace instruments and a number of bins for alloying and deoxidizing materials.

The hot top building has two working platforms about 200 ft long. Along the west side of the building is storage area for refractory materials.

The mold building also contains two working platforms from which molds are cleaned and coated before being sent to the pouring aisle.

When molten iron from the blast furnace reaches the open hearth, the 70-ton ladles are picked up by overhead crane and emptied into either of two 800-ton mixers located at the north end of the charging aisle. Iron is poured from the mixers into 100-ton ladles on transfer cars. A 200-ton track scale weighs the metal

TABLE II
Open Hearth Buildings and Cranes

Building	Length, ft	Width, ft-in.	Cranes		
			No.	Capacity, tons	Span, ft-in.
Stockyard	1026	101-5	3	10	75-0
Leanto	1512	60-0	..	...	...
Charging bay	1512	85-0	3	150/40	78-0
			3	12	Floor chargers
Pouring bay	1296	77-0	4	450/60/20	69-6
Ingot run	594	35	..	...	...
Hot top building	594	113-0	1	60/25	83-3
			1	25/10	83-3
Mold preparation	594	88-0	2	25/10	83-3
Cinder yard	432	88-0	1	60/25	83-3
Skullcracker	432	88-0	1	50/15	82-0
			1	30/15	82-0

put into each ladle. The transfer cars are shifted down the charging floor by a 25-ton electric locomotive, where the ladle is picked up by overhead crane and emptied into the furnace.

Steel is made at Geneva by the conventional scrap and hot metal open hearth process. There are now ten open hearth furnaces, each rated at 315 tons. As originally constructed, this shop had nine 225-ton furnaces. These have been enlarged and are now 89 ft-9 in. long x 25 ft-1 in. wide inside the steel work. They are built on 108-ft centers.

Hearths are 66 ft-5 in. long x 17 ft-3 in. wide, giving hearth areas of about 1150 sq ft. Furnace bottoms are made up of 24 in. of basic brick topped with 16½ in. of high magnesia rammed material, giving a bottom depth of 40½ in. at the center of the furnace.

Backwalls, with a slope of 10 5/16 in. in 12 in., are built of 18 to 22½ in. of chromemagnesite above the sill level, thickening out below the sill line where it is also topped by a layer of rammed bottom material. Front piers are built of burned magnesite brick 22½ in. thick at the bottom and 18 in. thick toward the top. Each of the seven charging doors is 5 ft-9 in. wide x 4 ft-8 in. high.

Front walls are 5 ft-1½ in. high from sill line to the spring line of the roof, while the spring line at the backwall is 4 ft-10¼ in. above the sill line.

Furnace roofs vary somewhat, with six furnaces having 18-in. silica brick roofs with 22½-in. ribs every fourth row, and four furnaces having 12-in. basic brick roofs with 15-in. ribs every fourth row. Roof span is 23 ft-7⅜ in. at the center of the furnace and the rise of the arch ranges 39 to 45 in. Longitudinally, the roof is horizontal except for about 11 ft from each end wall, through which the roof rises about 30 in.

Port ends and side walls are constructed of chromemagnesite brick. A single downtake 18 ft x 5 ft provides a sectional area of 90 sq ft at each end of the furnace. Slag pockets are built with fireclay brick walls and silica brick bulkheads. They have an area of about 285 ft. High alumina brick is used on the chill nose and the fantail nose.

Regenerator chambers on each end of the furnace are 30 ft long x 29 ft-6 in. wide inside of the brickwork. Originally these were divided into two sections, with sprung arches. Five furnaces have now been changed to single regenerators, with flat suspended roofs, thus gaining about 12 per cent more checker volume. This change will be carried through on the other furnaces.

Checkerwork is built to a depth of 14 ft, giving checker volume in the single chambers of about 12,300 cu ft on each end of the furnace. Checker flues are 7½ in. square.

When No. 10 furnace was added in 1952, it was designed with two-pass checkerwork. The regenerator chamber is 29 ft-9 in. wide x 37 ft-8 in. long. The first pass is 17 ft-9 in. long, the second 12 ft-5 in. A 4 ft-6 in. idle pass lies between. Checkerwork is 14 ft deep, giving about 12,600 cu ft of checkerwork on each end of the furnace. Checker flues are 7½ in. square in the first pass, 5¾ in. square in the second pass.

Steam blowers are installed in the floors of the regenerator chambers and flues to blow dust out toward the stack. Each of the four flues contains an electrically operated water-cooled slide valve for reversing the furnace. Beyond these valves, the four flues merge into two and then into one, which leads to a waste heat boiler and a 230-ft reinforced concrete stack. The boilers are fire-tube type with 7767 sq ft of heating surface, designed to produce about 20,000 lb of steam per hr at 175-psi pressure, 80-F superheat.

Each pair of furnaces is equipped with an electrostatic precipitator to remove dust and fumes from the waste gases.

Three-barreled artillery type burners introduce fuel oil, tar and coke oven gas through the furnace ends. The top barrel carries gas, the center barrel carries oil and the bottom barrel carries tar. Over-all, fuel oil makes up about 45 per cent of the open hearth fuel, tar about 30 per cent and gas about 25 per cent.

Air for combustion is provided by a 35,000 cfm fan for each furnace.

Fuel oil and tar are supplied to the open hearth through two separate 175-psi circulating systems, each equipped with two 180-gpm pumps. Fuel oil arrives at the plant by rail. Tank cars are unloaded and pumped into a 1,000,000-gal storage tank near the coke plant. There are also two 1,000,000-gal tanks for tar storage here. At the open hearth there are two 100,000-gal tanks, one for oil, one for tar.

A double bank of tubular heaters for heating oil and tar is located in the open hearth just ahead of the main supply headers to the furnaces. Steam tracer lines follow the fuel lines. Temperatures are manually controlled to give 180 and 200 F at the furnaces.

Each open hearth furnace is equipped with automatic reversal based on differential checker temperature. All fuel is metered, as are air flow, atomizing steam flow and the automatically controlled furnace pressure. Fuel-air ratio is automatically controlled with an oxygen analyzer. All instruments for each furnace are mounted on a panel board located in a control house. Fuel consumption averages about 3,400,000 Btu per net ton of ingots.

About 1,200,000 cu ft of oxygen are used per day, principally through roof lances which have been applied to four furnaces. The oxygen comes from the plant which supplies nitrogen for the coal chemicals plant and from a liquid oxygen converter station.

Miscellaneous equipment in the open hearth includes three dolomite machines, a hydraulic press for straightening stopper rods and an upright stopper rod oven of 88-rod capacity. A 7½-ton jib crane is installed in back

of each furnace to aid in handling materials and equipment.

In the process of enlarging the open hearth furnaces, Geneva engineers developed a prefabrication process which proved a great time-saver. The entire new furnace was built outside the shop, complete with brickwork, and then moved into place. An erection platform, consisting of specially designed beams, was installed on six ingot mold cars mounted on three sets of tracks. Roller assemblies on the top of the beams permitted the furnace to be rolled at right angles to the tracks. The complete furnace is moved into the shop, alined with its site and rolled across the intervening space on structural steel transfer bridges resting on heavy reinforced concrete pads.

The process enabled the plant to completely rebuild a furnace with only about 11 days outage between the last heat from the old furnace and lighting up the new one.

Scrap constitutes 20 to 35 per cent of the furnace charge, with the balance hot metal. The metallic charge totals about 682,000 lb. Fuel input is maintained at 138,000,000 Btu per hr until the slag is flushed, reduced to 115,000,000 Btu per hour during the lime boil and then restored to 125,000,000 Btu per hr for the finishing period.

Approximately 171 lb of limestone are used per ton of steel, plus 8 or 9 lb of fluorspar. The furnaces are designed for front flushing. The slag runs through the center door of the furnace, down a flush hole casting set in the charging floor and into the pit area. After the furnace taps, this slag is removed by heavy duty tractor equipped and transported to the open hearth slag dump.

Deoxidizing is performed in the furnace, ladle or ingot mold, depending on the desired product and the condition of the heat. Ferrosilican and aluminum are the principal deoxidizers.

Steel is produced principally in the lower carbon grades, with some medium carbons and low alloys. Analyses usually fall within the following ranges:

	Per cent
Carbon	0.04–0.30
Manganese	0.30–1.75
Silicon	0.01–0.23
Phosphorus	0.01–1.35
Sulphur	0.03 max
Copper	0–0.20

More than half of the product is mechanically capped, about one-third is rimmed, and the remainder killed or semi-killed.

Heats are produced in about 10 hr-52 min, tap-to-tap.

Heats of 315 tons are tapped into single ladles and poured into bottle top, hot top or open top ingot molds varying from 25 in. x 30 in. x 90 in. up to 34 in. x 67 in. x 120 in. Before teeming, mold interiors are given a dry spray of an asphaltite (gilsonite), which is fused into a coating by the heat of the mold.

Three pouring platforms are provided in the open hearth pit.

Some steel casting is done in the pouring pit of the open hearth, principally charging boxes for use in the department.

SLABBING MILL

J. V. MAZURIE
Division Superintendent—
Rolling Mills

Ingots coming to the slabbing mill from the open hearth first go to the stripper building, which is an extension of the soaking pit building. Here are two 200-ton stripping cranes capable of handling either big-end-up or big-end-down ingots. The railroad tracks extend into the soaking pit building, so that the trains of ingots, after stripping, may be pushed directly in, to be charged into the pits. Ingot track time may range from 1½ to 4 hours between pouring and charging into the pits.

There are 20 soaking pits, arranged in a double row paralleling the mill line. Four pits are 15 ft long x 16 ft wide x 16 ft deep. These are fired from both sides, near the top of the pit, and are equipped with metallic tubular recuperators. The other 16 pits are 15 ft long x 16 ft wide x 11 ft-6 in. deep, fired through a single burner at the center of the pit bottom. These pits have recuperators built of refractory tile. Pit covers are of flat, suspended design, and are handled by two cover cranes which span the double row of pits.

Each pit has its own fan, rated at 6600-cfm, 30-in. pressure or 7150-cfm, 5.5-in. pressure for the respective types of pits. Air is preheated to about 1500 F.

The pits are fired with a mixture of natural and coke oven gas. Automatic controls are applied to pit temperature, pit pressure and fuel-air ratio. Fuel consumption averages 650,000 Btu per net ton heated. Ingots are charged to the pits at temperatures ranging from 1600 F when ingots come direct from the open hearth down to atmospheric temperature when ingots are taken from stock. Heating time for hot ingots runs one to 1.5 times the track time.

Ingots are charged into and drawn from the pits by two 25-ton pit cranes. The heated ingot is brought to the mill table by a cable-driven ingot buggy.

All ingots are rolled through a 45-in. two-high reversing slabbing-blooming mill, designed to roll slabs 3¾ to 10 in. thick and 24 to 63 in. wide, in sheared lengths of 76 to 230 in., as well as blooms up to 14 x 18 in. x 76 to 220 in. sheared lengths. The housing of this mill is of closed top design and made of cast steel, with housing post areas of 816 sq in. Housing windows are provided with steel liners 3 in. thick. The windows are 10 ft-7 in. high x 53 in. wide inside of the liners.

Cast alloy steel rolls, of 45 in. diameter and 120 in. body length, run in composition bearings. The rolls carry a 72-in. bullhead and pass grooves of 14, 10 and 6 in. The roll necks are 28 in. in diameter x 34 in. long. The top roll is balanced by counterweights, with an adjustable counterweight for each roll neck operating through cast steel levers and four 6-in. steel rods.

The top roll is moved up and down by two forged steel single thread screws 18 in. in diameter x 2¼-in. pitch, driven by two 200-hp d-c motors operated under adjustable voltage control. Screw boxes, of alloy bronze, 31 in. outside diameter x 32½ in. long, permit a maxi-

Ingots are heated for rolling in 20 soaking pits arranged in a double row paralleling the mill line. The pits are fired with coke oven gas.

mum screw travel of 69 in. A roll lift speed of 26.7 fpm is available, giving a time of about 12 sec for the total lift.

The mill is driven through two forged alloy steel spindles 23 in. in diameter x 31 ft-1 in. long, by two 5000-hp, 40 to 80-rpm, 750-volt d-c motors arranged in a twin drive. These motors receive power from a motor-generator set consisting of four 2250-kw, 750-volt d-c generators driven by a 7000-hp, 13,200-volt, 514-rpm wound-rotor induction motor. This set also carries a 27,200-lb cast steel flywheel 164 in. in diameter.

A movable sideguard manipulator is installed on each side of the mill. The sideguards are fabricated steel box sections 27 ft long x 4 ft-4¼ in. wide. Each sideguard is connected to two rams spaced 16 ft-11 in. apart. The maximum opening between sideguards is 115 in. Their stroke is 9 ft-7 in., with a 3 ft-4 in. overtravel to permit changing table rollers.

The sideguards are operated by rack and pinion, driven through double reduction gearing by four 150-hp d-c motors under adjustable-voltage control.

The entry sideguard on the drive side of the mill is equipped with four cast steel lifting fingers to turn the ingot on the table. These fingers are operated by a 150-hp d-c motor.

Rolls are changed by means of a motor-operated rig having the capacity to withdraw both rolls with their chocks simultaneously.

Two feed rollers are installed on each side of the mill. They are of forged steel, 22 in. in diameter x 113½ in. long. Each roll is driven by a 45-hp low speed d-c motor

The slabbing-blooming mill at Geneva is a 45-in. x 115-in. two-high reversing unit driven by twin 5000-hp motors.

operated under adjustable voltage control.

Ingots coming to the mill pass over a receiving table 12 ft-1 in. long, a run-up table 26 ft-7 in. long, and an approach table 26 ft-7 in. long. Rollers in these tables are of solid forged steel, 18 in. in diameter x 84 in. long, and are installed on 29-in. centers. These table sections are driven at respective speeds of 200, 300 and 400 fpm by 75, 100 and 150-hp d-c motors under reversing-dynamic braking-plugging control.

Installed in this table line is an ingot turn-around and weighing scale where ingots may be turned end-for-end and simultaneously weighed.

Front and back mill tables are each 31 ft-5 in. long, and each has 14 solid forged steel rollers 20 in. in diameter x 115 in. long, on 29-in. centers. These tables operate at speeds up to 900-fpm. The rollers in both tables are now individually driven by special low-speed 45-hp d-c mill motors under adjustable-voltage control.

Following the back table is a section of runout table 26 ft-7 in. long containing 18-in x 84-in. rollers on 29-in. centers. It is driven at 405 fpm by a 150-hp motor. Next is a table section 16 ft-11 in. long driven at 313-fpm by a 100-hp motor.

Approximately 95 ft beyond the 45-in. mill is a vertical under-driven edger capable of edging slabs up to 10 in. thick. Since the slab is not in the edging rolls and the 45-in. rolls at the same time, no synchronization between the two is necessary. Hence, the edger is driven through reduction gears and bevel gearing by an 800-hp, 2300-volt, 360-rpm induction motor. The gearing has an 11.18 to 1 ratio, giving an edger roll speed of 32.1 rpm. Edger rolls are 40 in. in diameter x 11-in. face. Slab speed through the edger is 335 fpm.

Following the edger are three sections of table, each 26 ft-7 in. long and driven at 313 fpm by a 100-hp motor.

The main drives for the 45-in. stand and the edger are located in the adjacent motor-room, as are the switchgear, control equipment and two motor-generator sets which supply power for the mill auxiliaries operating under adjustable voltage control. Each set consists of three 200-kw, three 150-kw and one 100-kw generators of 250 volts, driven at 1200 rpm by a 1250-hp, 2300-volt synchronous motor.

The motor room is ventilated by a recirculating system. Air is drawn down through the rotating machinery, passes through surface type air coolers and travels back up into the room. Make-up air for the system is cleaned by an electrostatic precipitator.

Scale from the steel being rolled falls through the mill tables into a flume beneath the mill line and is washed down into a scale pit outside the building, from which it is removed by crane and clam shell bucket.

The slabbing mill is lubricated by a 14,400-gal, 250-gpm circulating oil system for all drive equipment, a duplicate system for tables, etc., a 4500-gal, 150-gpm system for motor-room bearings, and 12 grease systems.

Located about 116 ft beyond the edger is an up-and-down cut shear with a capacity for 10 x 60-in. slabs or 14 x 18-in. blooms. The shear has a 17½-in. clear opening and a 19-in. stroke. The shear develops a maximum knife pressure of 3,000,000 lb, and is driven by two 500-hp d-c motors under adjustable voltage control. Two-speed reduction gearing gives operation at rates of 9 or 16.6 cuts per min.

The shear gage, motor operated, is graduated for lengths of 5 to 20 ft in one-inch increments.

From the shear, a motor-driven chain flight conveyor moves crop ends to a crop pit, 10 x 50 ft, from where they are removed by magnet crane into railroad cars.

About 80 ft beyond the shear, a double ram pusher with ten fingers on 24-in. centers pushes slabs from the table to the right onto a seven-chain transfer 105 ft long x 20 ft wide. Sloping upward 6 ft-11 in. this transfer, with a maximum speed of 100 fpm, carries slabs to a table line in the adjacent slab storage building. This table is actually an extension of the charging table serving the slab heating furnaces in the strip mill. Slabs from the transfer may proceed in one direction for immediate charging into these furnaces. This is seldom done, however. Rather, the slabs are moved in the other direction and handled by pushers, pilers and transfer cars to storage. The cars are 7 x 22 ft and run on 20-ft gage tracks.

In the storage building there is a slab conditioning area served by two 15-ton gantry cranes. All conditioning is performed by hand scarfing.

Blooms coming from the shear are carried about 50 ft past the slab transfer to another pusher which moves them to the left of the mill line to a 21-ft gage transfer

From the blooming mill, slabs are moved over a chain type transfer into the adjacent slab storage building.

To insure good quality, surface defects on the slabs are scarfed out before the steel is sent to the strip mill.

car shuttling between the slabber and the structural mill bloom storage.

For slab rolling, the 45-in. mill receives ingots ranging up to 34 x 66 x 115 in. It produces slabs 24 to 63 in. in width and 3¾ to 10 in. thick. For blooms, ingots run up to 26 x 39 x 106 in. Bloom sizes normally run from 7 x 9 in. up to 10 x 14 in. Approximately 94 per cent of the mill schedule goes to slabs.

STRUCTURAL MILL

The structural mill is housed in a group of five building bays. The main mill aisle is 1075 ft long x 115 ft wide. Adjacent bloom storage to the east is 1075 ft long x 105 ft wide. On the other side of the main building is a smaller aisle, 60 ft wide, housing the motor room. Five bays running at right angles to the main building house finishing and shipping facilities. The buildings cover an area of about 15 acres and are placed so that the mill is parallel to the slabbing mill with the bloom stockyard located opposite the slab shear.

Hot blooms come from the slabbing mill on a 20-ton transfer car which travels in a depressed runway across the mill yard. The car is remotely controlled either from the blooming mill shear pulpit or from a 25-ton gantry crane in the structural mill bloom stockyard. The gantry crane moves blooms with C-hooks to cooling skids. An overhead, 25-ton, double hook crane moves blooms from the skids to inspection and conditioning beds and later to the heating furnace charging tables.

Blooms are heated for the structural mill in three triple-fired continuous furnaces with hearths 20 ft wide x 65 ft long. The furnaces are rated at 50 tons per hr each and were designed to handle blooms up to 12 in. thick. They are fired with coke oven gas or oil. Air for combustion is preheated to about 550 F in silicon carbide tubular recuperators.

The charging ends of the furnaces are located in the stockyard and blooms are brought to the furnaces by the charging table which runs across the furnace ends. A double rack pusher for each furnace moves blooms into and through the furnace and out on to the mill approach table.

Heated blooms first go through a 32-in. two-high reversing stand. This unit has rolls 32 in. in diameter x 70 in. body length. The 18-in. roll necks operate in water-lubricated composition bearings. The top roll is mechanically balanced and has a maximum lift of 29 in.

The roughing stand is driven by a 4000-hp, 50/120-rpm, 700-volt motor under adjustable-voltage control. Power for this drive comes from two 1750-kw, 700-volt d-c generators driven at 514 rpm by a 3500-hp, 13,800-volt induction motor. This set also includes a 24-ton steel plate flywheel.

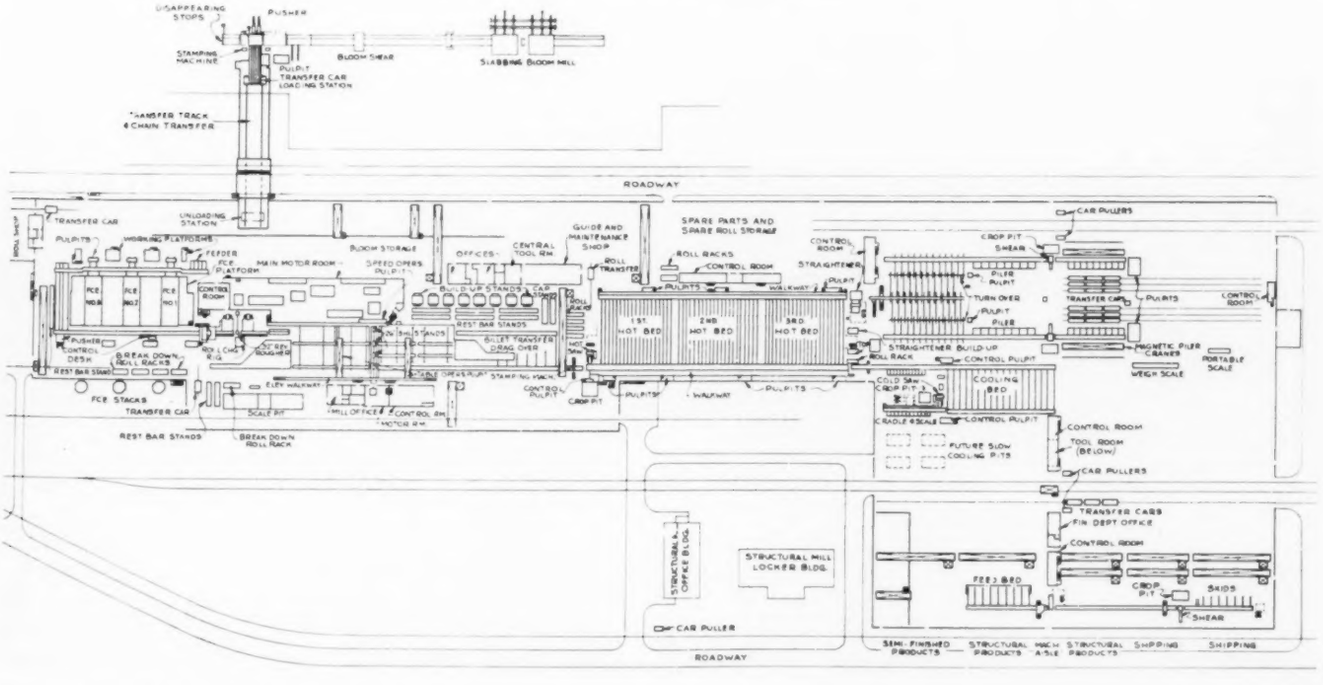
Mill pinions are herringbone, of 32-in. pitch diameter, 60-in. face.

In front and in back of the mill are manipulators driven through racks and pinions by four 75-hp mill type motors. The sideguards are 20 ft-8 in. long x 2 ft-1 in. wide. Manipulator fingers are provided on the drive side of the mill, front and back, driven by four 35-hp motors.

The top roll of this stand is moved by 12-in. screws of 1½-in. pitch driven by two 75-hp motors with stabilizing windings. The control provides for series-parallel connection of the motors in combination with shunt field forcing and weakening. Armature shunting is also used. Thus, a wide speed range is obtained with ample torque and close speed regulation at low speeds.

About 175 ft from the roughing stand are three 26-in. stands, side by side. Two of these are three-high intermediate stands with 26 x 66-in. rolls. The third is a two-high finishing stand with 26 x 48-in. rolls. Extra stands are provided which can be built up in advance to save time in changing sizes or sections. All roll necks run in water-lubricated composition bearings. Roll adjustment is manual.

General layout of structural mill.



Blooms roughed down in a 32-in. reversing stand are finished on these three 26-in. stands into structural shapes from 4 to 15 in. in size, or into round or square bars.

The two three-high stands are driven by a 4000-hp, 80/160-rpm, 700-volt d-c motor. The finishing stand is driven by a 2150-hp, 95/190-rpm 700-volt motor. Both motors draw power under adjustable voltage and shunt-field control from a motor-generator set composed of three 1750-kw, 700-volt d-c generators driven by an 8000-hp, 514-rpm, 13,800-volt synchronous motor.

High pressure spray nozzles are provided to remove scale ahead of the first intermediate stand and the finishing stand.

On each side of the 26-in. mill are two traveling tilt tables and two trailing tables. The tilt tables are about 46 ft long and the trailers about 48 ft long. Each is driven by a 50-hp series motor to give a maximum table speed of 492 fpm. The tables move sideways from stand to stand at speeds up to 171 fpm, driven by three 50-hp motors on each tilt table and two 50-hp motors on each trailer. Supplementary run-out chutes installed on each side of the mill permit the mill to handle finished lengths up to 220 ft.

A runout table and a drag-type transfer allow billets rolled on the roughing stand to by-pass the 26-in. mill, moving over the first stand spindles by means of the traveling tables.

Main drive motors, motor-generator sets, control equipment and switchgear are housed in a motor room 225 ft x 58 ft, located partially in the mill building, partially in the stockyard. The roof has removable sections to allow the mill crane to service the principal electrical apparatus.

Each of the three main drive motors is totally enclosed and designed with a self-contained, recirculating ventilating system. Motor-generator sets are cooled by a downdraft ventilating system. Make-up air for this system is cleaned by electrostatic precipitator. Treated water is used in the surface-type air coolers and then is used for cooling in the heating furnaces before being returned to the cooling reservoir.

A 2000-kw, 12-tank mercury rectifier is also installed in the motor room, supplying 250-volt d-c power for auxiliary drives.

Sections leaving the 26-in. mill are conveyed on roller tables to a hot saw, two saw gages and a stamping machine about 270 ft away. They then proceed to the structural hot bed, 290 ft long x 87 ft wide, divided into three sections which can be operated individually to handle lengths up to 100 ft.

After crossing the hot bed, sections are conveyed to an eight-roll straightener and delivered to a 100-ft long double inspection bed. Each half of the bed is 50 ft wide and is equipped with turnover devices for angles, channels and beams.

Each half of the inspection bed is provided with an 800-ton press-type shear with motor-operated gage. Delivery tables, transfers, marking beds and nesting equipment complete the finishing facilities. Sections are then moved to the shipping area by two special cranes, each with two trolleys with vertical rams carrying special magnets adapted to handle structural sections.

In the shipping area there is a refinishing line for restraightening and cutting sections.

Billets from the 26-in. mill or direct from the 32-in. mill are carried past the structural hot bed to a separate cooling bed 135 ft long x 55 ft wide, of walking-beam design. A cold saw, gage and cradle scale is provided here.

The structural mill receives blooms ranging 172 to 220 in. long in a range of sections: 7 x 9 in., 7½ x 9 in., 8 x 10 in., 9 x 10 in., 10 x 13 in., 10 x 14 in. and 5 x 20 in. It produces rounds 2½ in. to 6 in. in diameter; squares from 2¼ in. to 7 in.; channels 4 to 15 in.; I-beams 4

to 15 in.; H-beams 4 and 6 in.; angles 3½ x 3½ in. to 6 x 6 in. or 9 x 4 in. Billets 6 x 6 in. and up are usually rolled direct from the 32-in. mill; smaller billets are finished on the 26-in. stands. The mill averages about 50 tons per hour or 10,000 tons per month on single-turn operation.

132-IN. MILL

The 132-in. mill was originally designed for the production of plate. It was of semi-continuous type, with a scale breaker, a broadside stand, a reversing rougher, another scalebreaker and four finishing stands. To convert the mill for rolling strip, it was necessary to add a slab squeezer, a vertical edger, two finishing stands, two coilers and coil handling facilities.

The mill is located in the same building and in line with the slabbing mill. The buildings extend about 3450 ft from the stripper building at the end of the soaking pits to the end of the plate finishing department.

Slabs, ranging up to 63 in. in width and 4 to 9 in. in thickness, are brought from storage by transfer cars and overhead crane, and unloaded on to the charging table which runs across the back ends of the furnaces.

There are three slab heating furnaces, rated at 125 tons per hr each. They are 92 ft-8¼ in. long over-all, and have hearths 85 ft-10½ in. long x 21 ft wide. They are fired with coke oven gas or oil in the heating zone, with seven burners overfiring and eight burners underfiring the zone. Slabs move through this zone on water-cooled skid pipes supported on refractory piers. The 17-ft soaking zone has a solid refractory hearth and is overfired by eight burners. The furnaces have flat, suspended roofs with 2½ in. of insulation.

Air for combustion is supplied by a 5300-cfm, 18-in. water column fan for each furnace. Air is preheated to about 800 F in metallic tubular recuperators which have replaced the original silicon carbide tubular units. Induced draft for each furnace is provided by a 550-cfm, 13.8-in. water column stack ejector fan. Burner capacity on each furnace totals 450,000 cu ft of coke oven gas per hr.

Each firing zone of each furnace is equipped with a fuel input control and a fuel-air ratio control. Each furnace also has two temperature controls and furnace pressure control. An oxygen analyzer also aids in efficient furnace operation. Fuel consumption averages 2,200,000 Btu per ton of slabs heated.

Slabs are moved through the furnace by a double head pusher driven by two 100-hp mill type motors. Through the action of the pusher, a heated slab is expelled from the furnace on to the mill approach table, which is about 188 ft long, driven in four sections through line shafts by four 50-hp motors.

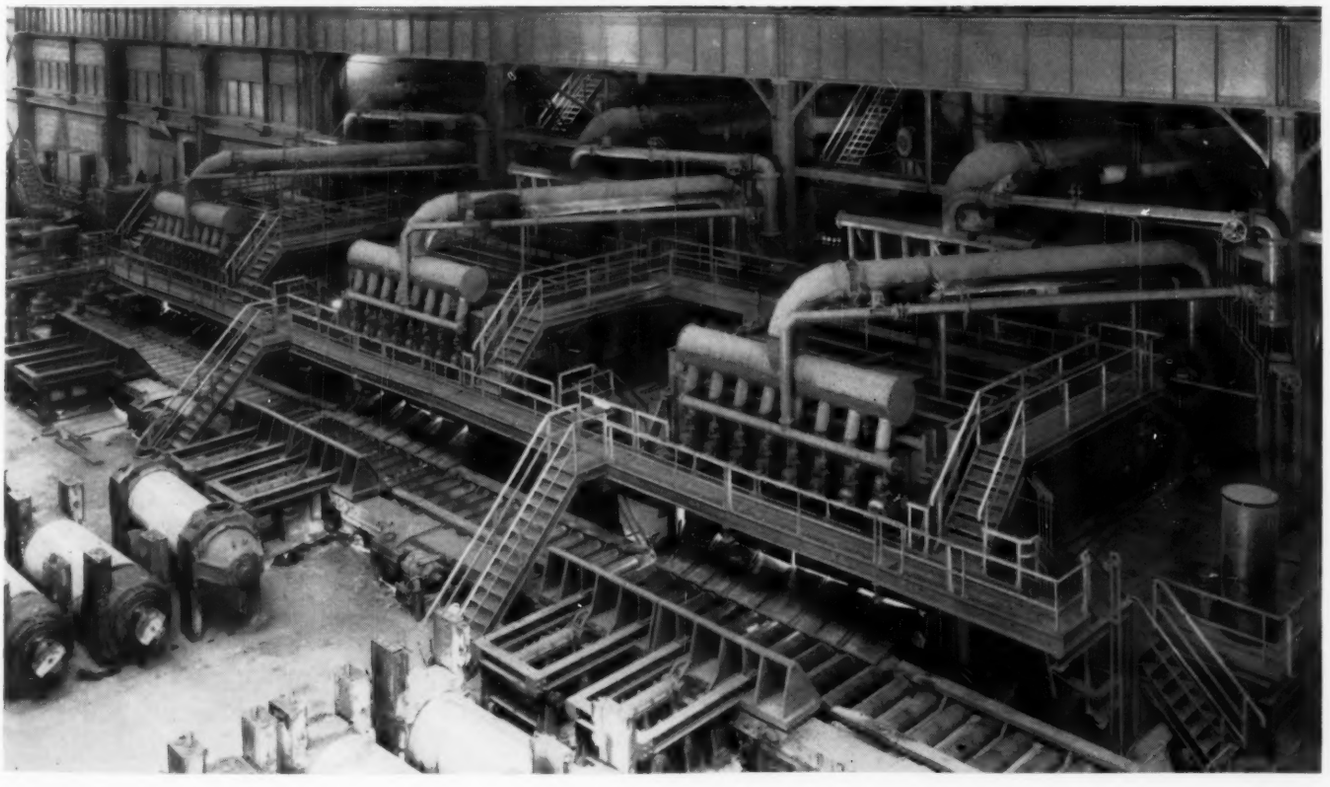
To help maintain width and to true up slab edges, a separate under-driven vertical edger unit was installed as the first stand of the mill. This unit has rolls 45 in. in diameter x 17-in. body length. The rolls are adjustable to handle slab widths from 18 up to 127 in. The edger is driven by two 250/650-hp, 230/600-volt, 375/1050-rpm d-c motors. These motors draw power from a motor-generator set made up of two 500-kw, 600-volt d-c generators driven by a 1450-hp, 6900-volt, 900-rpm synchronous motor. The motors drive through reduction gearing of an over-all ratio of 19.5, giving roll rpm of 19.2/53.8 or face speeds of 226 to 633 fpm.

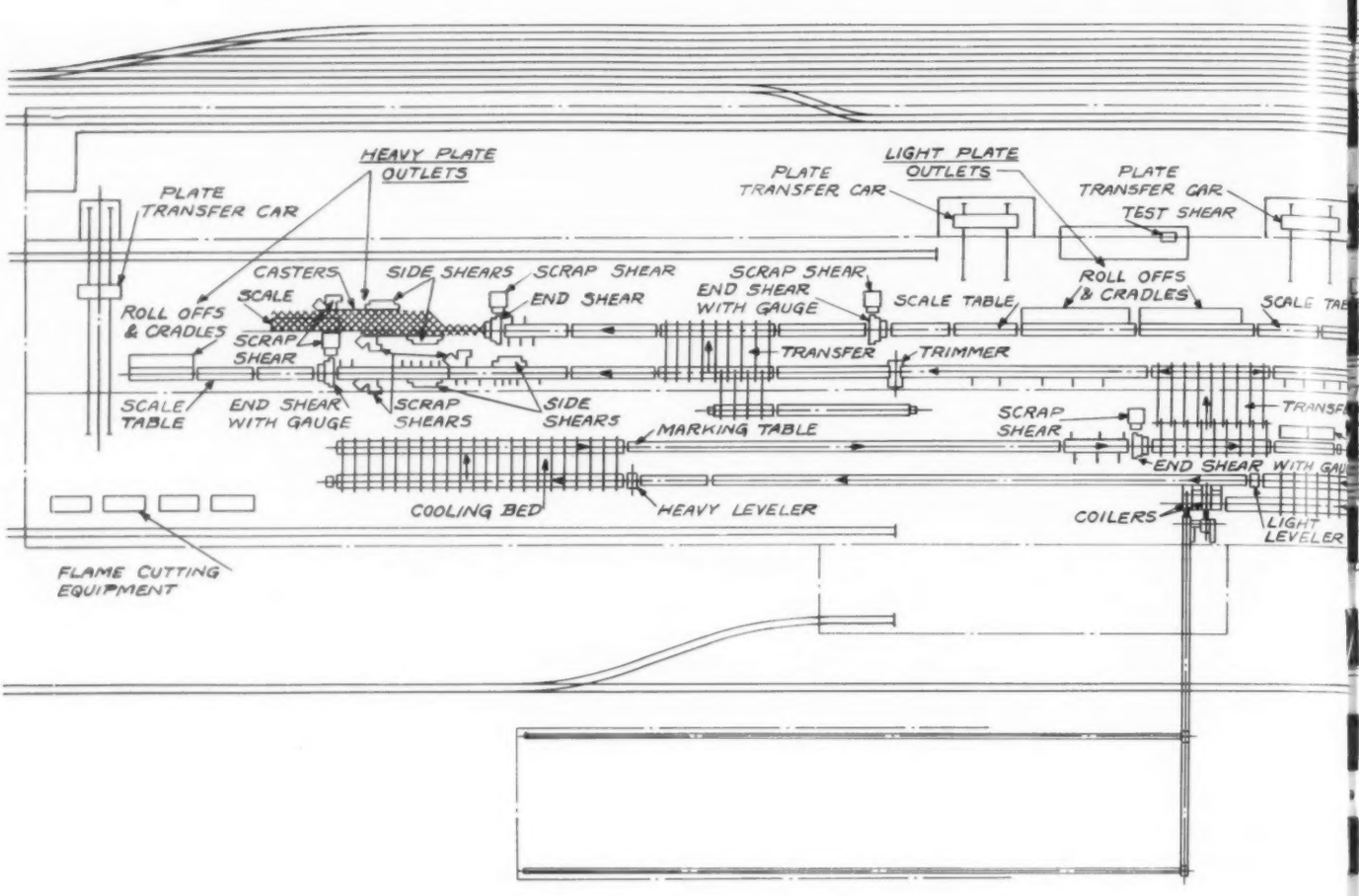
This edger is capable of taking heavy edging drafts and is very effective in cracking scale from the slab.

Edger rolls are adjusted by two 75-hp motors.

Next is No. 1 scalebreaker, 20 ft-8 in. beyond No. 1 edger. This is a 36-in. x 70-in. two-high stand equipped with roller bearings. The rolls separate to a maximum

Three triple-fired continuous reheating furnaces heat slabs to be rolled in the 132-in. mill. They are fired with coke oven gas.





opening of 12 in., actuated by a 35-hp mill type motor. This stand is driven by a 1250-hp, 6600-volt, 240-rpm wound-rotor induction motor. A flywheel reduction drive of 7.5 ratio gives a roll speed of 32 rpm or 300 fpm.

A broadside stand is located 33 ft-11 in. beyond the scalebreaker. This is a 42-in. and 56-in. x 132-in. four-high unit, driven by a 4500-hp, 6600-volt, 150-rpm wound-rotor induction motor. On the armature shaft of the motor there is a 20-ft segmental cast steel flywheel of 45,000 hp-sec total energy content. A 7.846 gear ratio gives roll speeds of 19.1 rpm or 210 fpm. Work rolls operate in babbitted bearings, backup rolls in oil-film bearings. Backup rolls are also provided with outboard roller thrust bearings. Mill screws are operated by two 75-hp motors. Maximum roll opening is 12 in.

In this stand, slabs up to 128 in. long may be turned through 90 degrees and cross-rolled, thus increasing slab width beyond that obtainable from the slabbing mill. To position the slab for cross-rolling, turntables are installed on each side of the broadside mill. These tables are lifted hydraulically and turned by 10-hp motors. A slab pusher on the entry side of the mill assists in squaring and entering the slab for the spreading pass. It is operated by two 75-hp motors.

About 38 ft beyond the broadside stand is a hydraulic squeezer capable of handling slabs up to 126 in. wide and 12 in. thick. This unit trues up the slab and squares its edges after broadsiding. It is operated by a 275-hp mill type motor.

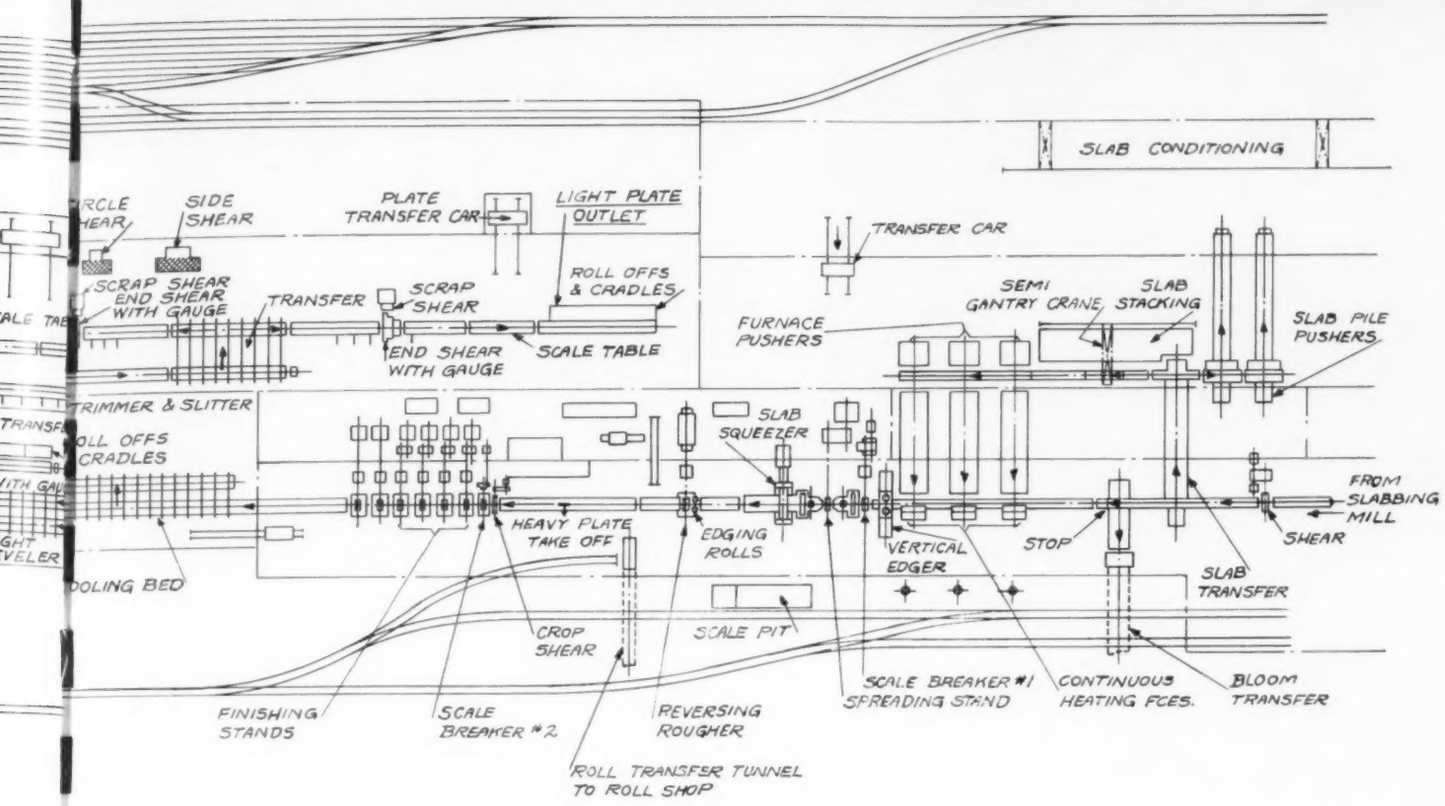
The reversing rougher, which is 128 ft-8 in. beyond the broadside stand, is a 38 and 56-in. x 132-in. four-high unit. It has roller bearings on the work roll necks, oil-film bearings on the backup necks. The top roll is hydraulically balanced and is moved by mill screws driven by two 100-hp motors under constant voltage control. A magnetic clutch permits the two screws to be operated individually or in unison. Maximum roll opening is 9 in. and a maximum screw travel speed of 51 in. per min is available. A 9-pass preset automatic screwdown control with optional manual control is provided. This control is based on a rotary limit switch, selector, plug boards and schedule and pass selector control panels. One schedule may be set up while another is being run.

The rougher is driven by a 7000-hp, 700-volt, 25/60-rpm, double armature d-c motor which develops full-load torque at 25 rpm of 1,470,000 lb-ft. This motor draws power from a motor-generator set consisting of four 1750-kw, 700-volt d-c generators and a 185,000-hp-sec flywheel driven by a 7000-hp, 6900-volt, 514-rpm wound rotor induction motor.

Rolling speeds range up to 597 fpm.

A pilot generator on the rougher drive motor serves to match the separate edger speed with that of the rougher. Rotating field control is applied to the adjustable voltage generators for control of rougher and edger.

Additional edging is obtained from vertical edging rolls, 26 in. in diameter x 17½-in. body length, mounted 7 ft ahead of the horizontal roughing rolls in a separate housing secured on close centers to the entry side of the rougher housing. These rolls are top driven through vertical spindles from overhead worm drives mounted along side the horizontal roll screwdown. The edging rolls are driven by two 250/650-hp, 230/600-volt,



General layout of 132-in. mill.

375/980-rpm d-c motor under adjustable voltage control. The reduction gearing of 8.5 ratio gives roll speeds of 44.1 to 114 rpm or 301 to 778 fpm.

Reversing mill tables on each side of the rougher are 38 ft long, each driven at speeds up to 1000 fpm by two 75-hp motors under adjustable voltage control. Just ahead of the rougher are seven table rollers alternately tapered and individually driven by special low speed 12-hp d-c mill type motors. This skewing table was installed to permit broadsiding on the rougher when it might be necessary.

The delay table between the rougher and the finishing train is designed with 14-in. rollers driven in two sections through lineshafts by two 50-hp motors. Table speeds range up to 452 fpm maximum.

Just ahead of the finishing train, and 177 ft-4 in. from the roughing stand is a flying crop shear for squaring up the ends of the breakdown if desired. It is driven by a 230-hp motor and is capable of shearing hot steel sections up to 128 in. wide x 1 in. thick.

The first unit of the finishing train, No. 2 scalebreaker, is located 184 ft-9 in. from the roughing stand. It is a 25½ x 132-in. two-high stand, with composition roll neck bearings. The top roll is supported by a spring balance. Mill screws are operated by a 15-hp motor. The stand is driven by a 500-hp, 600-volt, 150/600-rpm d-c motor. Its reduction gear has a ratio of 8.36, giving roll speeds of 17.9/71.6 rpm or 120/480 fpm. A distance of 15 ft-2 in. separates the scalebreaker from the first finishing stand.

The six finishing stands are all 30-in. and 59-in. x 132-in. four-high units, with roller bearings on the work rolls and oil-film bearings on the backups. They are spaced on 19-ft centers. Mill screws on each stand are driven by two 75-hp motors connected by a magnetic clutch.

Each stand is driven by a 5000-hp, 600-volt d-c motor, the first four through speed reducers, the last two direct. Motor speeds, gear ratios, etc., are as follows:

Stand	Motor rpm	Gear ratio	Roll rpm	Roll face fpm
1	125/245	3.89	32.2/63	253/495
2	125/245	2.95	42.3/83.2	333/652
3	115/245	1.78	64.4/137.5	509/1080
4	115/245	1.28	89.7/191	707/1500
5	115/245	Direct	115/245	907/1925
6	135/294	Direct	135/294	1063/2310

As originally installed, the first five drive motors were identical and still have duplicate armatures. Base speed, however, was lowered on No. 3, 4 and 5 stands to improve the speed cone of the train. This was done by over-exciting the motor fields without exceeding their thermal capacity. In the same way, the base speed of No. 6 stand was lowered from 150 rpm to 135 rpm.

All motors driving the finishing train draw power from three duplicate motor-generator sets, each consisting of two 3500-kw, 600-volt d-c generators driven at 360 rpm by a 9800-hp, 6900-volt synchronous motor. When rolling strip all six generators feed to a common bus, but a tie may be opened, separating No. 5 and 6 stands from the other four. This enables bus voltage for the two groups to be adjusted separately, giving a

Slabs may be cross-rolled in this broadside mill to increase width beyond that available from the slabber. Here a slab is being returned to its original axis by an elevating turntable.

View of reversing roughing stand, showing integral edging rolls on entry side. Just ahead of the rougher, seven table rollers, alternately tapered and individually driven, permit turning for broadsiding when necessary.

wider range of speed adjustment than may be required when rolling plate.

Several years ago, motor speed regulating equipment, including a new bus voltage regulating system, was installed for the six finishing stands. These operate on the drive motor fields. This system uses a combination of magnetic and rotating regulators. Coarse speed adjustments are made by generator voltage control and by motor-operated motor field rheostat. Vernier speed regulation is made by a buck-boost exciter in the motor field circuit. Fine speed adjustment is accomplished by a small rheostat in the control reference circuit.

The system operates by comparing a programmed d-c reference voltage against stand speed in the form of a tachometer voltage furnished by 0.6-kw pilot generators on the end of the drive motor shaft. If the two values do not match, magnetic amplifiers and a field-forcing exciter buck or boost the motor field until motor speed matches the reference.

Through this system, the speed operator can control motor characteristics from zero droop to the maximum six per cent droop of the system.

A recently developed regulating system automatically maintains gage in the hot finishing train. Specially built pressure gages on the finishing stands measure the rolling pressure. Readings from these gages are translated into electrical impulses which actuate control systems to change screwdown settings and speeds of the main drive motors.

At present, the pressure gages in No. 1 and No. 2 stands automatically adjusts No. 2 stand screwdown. The pressure gage on No. 4 stand works to increase the speeds of No. 4, 5 and 6 drives, adjusting strip tension. A radiation pyrometer ahead of the finishing train actuates all six finishing stand screwdowns to compensate for slab temperature. An x-ray thickness gage at the exit of the finishing train also actuates all six finishing screwdowns to compensate for mill drift. Further, the pressure gage in No. 1 stand acts after the tail end of the strip leaves No. 1 stand to slow down No. 2 drive. This reduces tail end over-gage.

The combination of speed regulation and the more recent gage control system has resulted in greatly improved uniformity of hot-rolled product.

An electronic width gage at the finishing train exit also provides the operators with a check on product uniformity.

Loopers are provided between the finishing stands to take up slack that may occur in the strip. They are driven by torque motors rated at 75 hp, under manual control. Guides are also provided between the finishing stands to insure proper entry and delivery of the strip at each stand.

To insure good surface on the rolled product, hydraulic sprays for descaling and cleaning the strip are located on both sides of No. 1 scalebreaker, on the entry side of the reversing rougher and on the delivery side of No. 2 scalebreaker. Water for these sprays comes from three 1250-gpm, 1200-psi centrifugal pumps driven by 1250-hp motors. Steam jets are also installed at the delivery sides of No. 5 and 6 finishing stands.

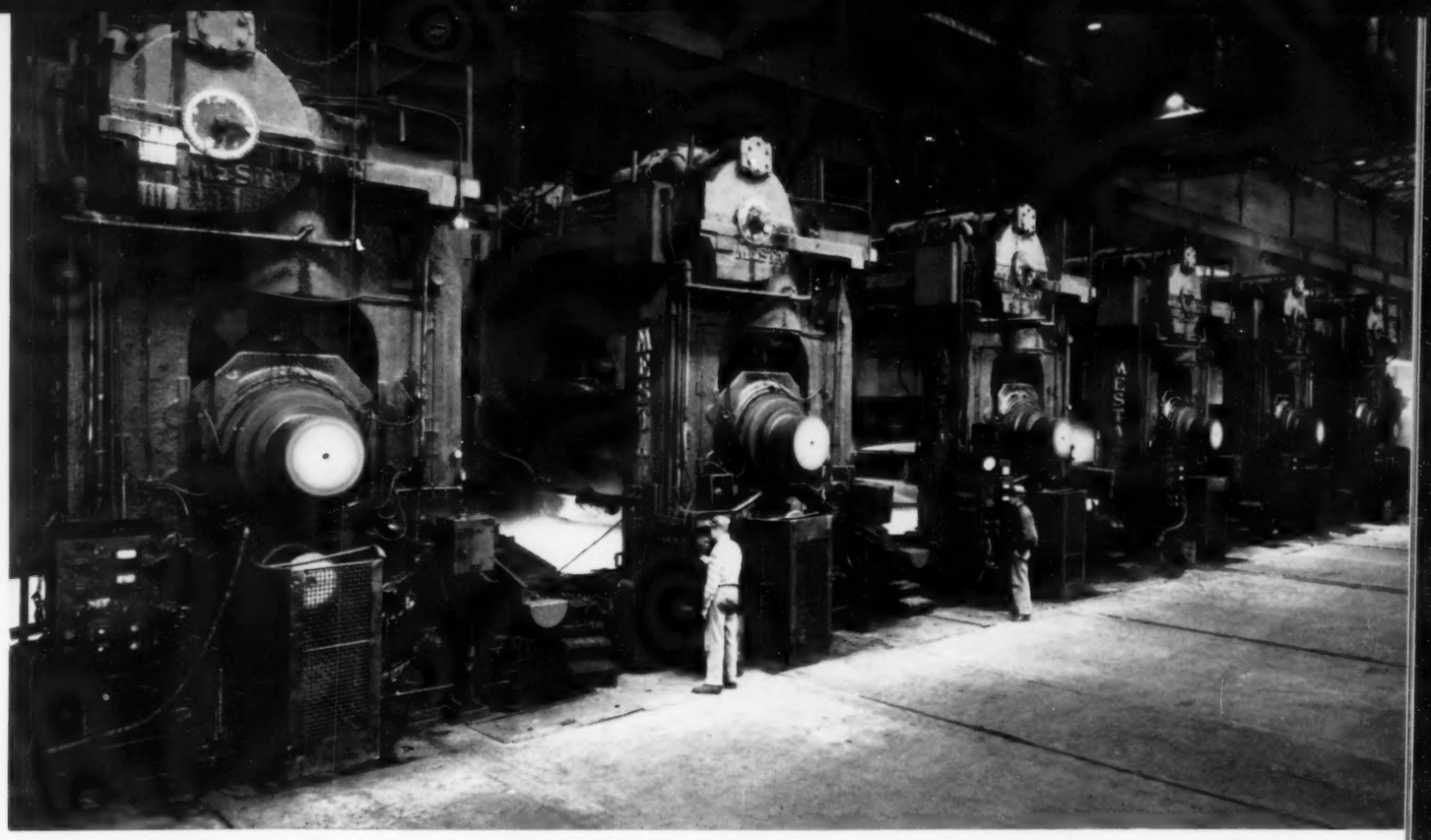
The 132-in. mill is lubricated by seven recirculating oil systems and eleven automatic grease systems. A 25,000-gal, 315-gpm oil system serves the backup roll neck bearings. The other oil systems range 500 to 8100-gal storage capacity and 75 to 315-gpm circulating rate, and provide lubrication for motor bearings, pinion stands, screwdowns, etc.

The eleven automatic grease systems supply lithium-base grease of 320 to 500 viscosity to about 700 points throughout the mill.

The hot mill motor room, lying between the slab storage and the mill building, contains the main mill drives with their reduction gears, control equipment, switchgear and motor-generator sets previously mentioned. Here are also two motor-generator sets serving the roughing mill auxiliaries which operate on adjustable voltage. One set has a 500-kw, 600-volt generator, two 150-kw, 250-volt generators and two 100-kw, 250-volt generators. The other has a 500-kw, and two 150-kw generators. Each set has a 40-kw direct-connected exciter and is driven by a 1250-hp, 6900-volt, 900-rpm synchronous motor. These sets serve the edger mounted on the roughing stand and the reversing tables.

Another set, with one 650-kw, two 400-kw and one 100-kw generators, serves the individual drive motors on the runout table rollers. It is driven by a 2250-hp synchronous motor.

Two other sets (one a 1000-hp, four-unit set, one a



The six finishing stands, all 30-in. and 59-in. x 132-in. units are spaced on 19-ft centers. Each stand is driven by a 5000-hp, 600-volt d-c motor.

400-hp, four-unit set), feeding the coiler motors and pinch roll drives, are also located in the motor-room.

Rotating machinery in the motor room is cooled by air forced from the room down through the units, through surface type coolers and filters, and back into the room. Make-up air for the closed system is drawn through two air filters.

Leaving the finishing train, strip proceeds over a runout table to two downcoilers about 400 ft distant, capable of forming strip up to 77 in. wide and 0.048 to 0.25 in. thick into coils of 30 in. inside diameter, 56 in. outside diameter, weighing 450 lb per in. of width. The runout table is driven by individual 7½-hp d-c motors for each roller. Water sprays are provided on the runout to cool product as required by metallurgical considerations.

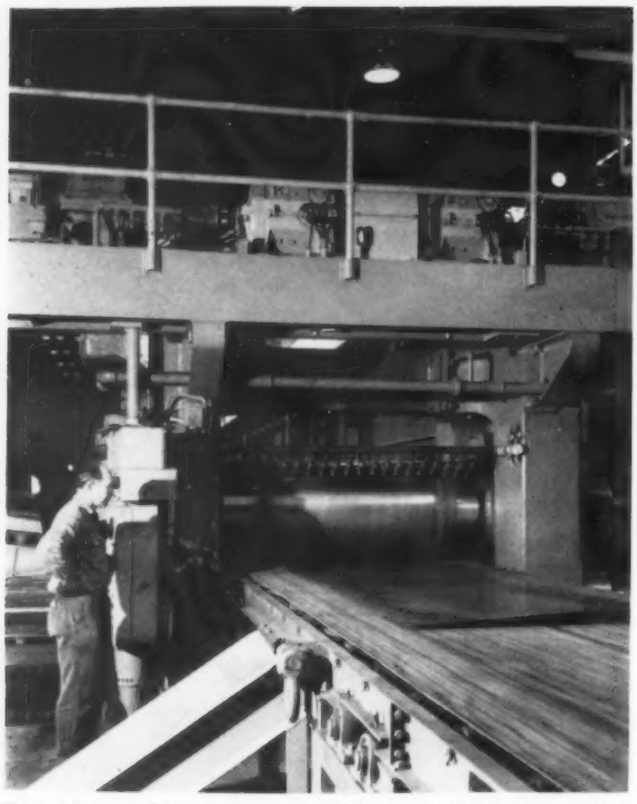
The mill rolls strip 26 to 75 in. wide and $^{3}/_{64}$ to $^{3}/_{16}$-in. thick. Plate product runs 38 to 127 in. wide and $^{3}/_{16}$ to 3 in. thick. At present, the product is about 33 per cent plate, 67 per cent coils, but this varies and the proportions may reverse. The major portion of strip is sent to the company's plant at Pittsburg, California, where complete cold reduction and finishing facilities have been installed for the production of cold rolled and galvanized sheets and tinplate.

Completed coils are pushed off the coiler mandrels to a downtilter which places them on a double strand chain conveyor. Coil weights are recorded by a scale. This conveyor runs at right angle to the mill line into the raw coil storage building, where it intersects at 90 degrees with two more conveyors running along the sides of the storage area. The system can handle about 80 coils per hr.

The coil storage building, 139 ft wide and 425 ft long, is divided into two aisles and served by three 15-ton and one 20-ton cranes. It is adjacent to a sheet finishing building, 120 x 425 ft, housing a temper mill and a shearing line. This building is served by a 35/10-ton crane and a 25/10-ton crane. Coils are moved over a transfer from storage.

Coils are first put through a shearing line composed

The downcoilers can handle strip up to 77 in. wide and 0.048 to 0.25 in. thick, forming coils 30-in. inside diameter, up to 59-in. outside diameter, and up to 450 lb per inch of width.



This 32-in. x 84-in. temper mill is used to give hot rolled sheets a skin pass to flatten and stiffen them.

of a processor, side trimmer, shear, leveler, classifier and piler. It cuts up coils of steel 26 to 72 in. wide and 0.06 to 0.18 in. thick into lengths of 4 to 20 ft.

These cut lengths may proceed to a 32 x 84-in. two-high temper mill which is driven through a 9.6 to 1 reduction gear set at speeds up to 1000 fpm by a 500-hp, 600-volt, 575/1150-rpm d-c motor. A light pass through this mill will flatten the sheets and make them a trifle stiffer. The mill is followed in line by a backed-up roller leveler and a piler.

An 800-hp three-unit motor-generator set serves the shearing line and a 1250-hp two-unit set supplies the temper mill.

When the 132-in. mill is rolling plate, the product is moved over a 260 x 21 ft-8 in. chain and grid cooling table from the runout table ahead of the coilers to a parallel table line. This line is in turn connected to three more parallel lines by cooling beds and transfers. At suitable points on these tables there are roller levelers, rotary side trimmers, end shears, rolloffs and cradles where plate of various thicknesses may be removed.

A central roll shop, convenient to the three mill areas, contains two 60-in. lathes, one 50-in. lathe, four 42-in. lathes, two 60-in. roll grinders, one 44-in. grinder and one 36-in. grinder. Rolls and roll neck bearings for all mills are serviced here.

QUALITY CONTROL

The control of manufacturing processes and quality of products is the joint responsibility of the metallurgical, chemical and inspection department. Incoming raw materials are chemically analyzed to check their acceptability. Chemical analyses are also essential to guide the production processes.

Each order for steel is checked to determine that the type ordered is proper for the intended application. A line-up of instructions for production practices is then prepared. This line-up includes such factors as specified chemistry, tapping temperature, slag characteristics, deoxidation practice, mold type, reheating procedures, rolling practices, finishing temperatures and inspection requirements. Metallurgists in the producing departments see that these recommendations are followed and record the results obtained. Samples are taken at various stages for chemical and physical testing.

All products are closely inspected to make sure that the material meets the specified size and shape tolerances, and is suitable for the customer's purpose.

The chemical and metallurgical laboratories and offices are housed in a well equipped building located between the blast furnaces, open hearth and rolling mills. Other chemical laboratories are located at the coke plant, the nitrogen plant and the Ironton plant.

UTILITIES & SERVICES

MYRON E. STRATE
Division Superintendent—
Maintenance & Utilities

Electric power for the Geneva plant is for the most part generated in the plant, but there is a hook-up with the power company serving the area that permits an interchange of power. The utility company transmits power at 138,000 volts to an interchange substation. Here a 90,000-kva, 138,000/13,800-volt transformer bank provides the link between the utility and the steel plant.

Power is generated by a 50,000-kw, 80-per cent power factor, 3-phase, 60-cycle, 13,800-volt, 1800-rpm turbo-generator. The turbine has 16 impulse stages and operates on 450-psi, 750-F steam. It is equipped with a two-pass 50,000 sq ft surface condenser with two 26,000-gpm circulating water pumps.

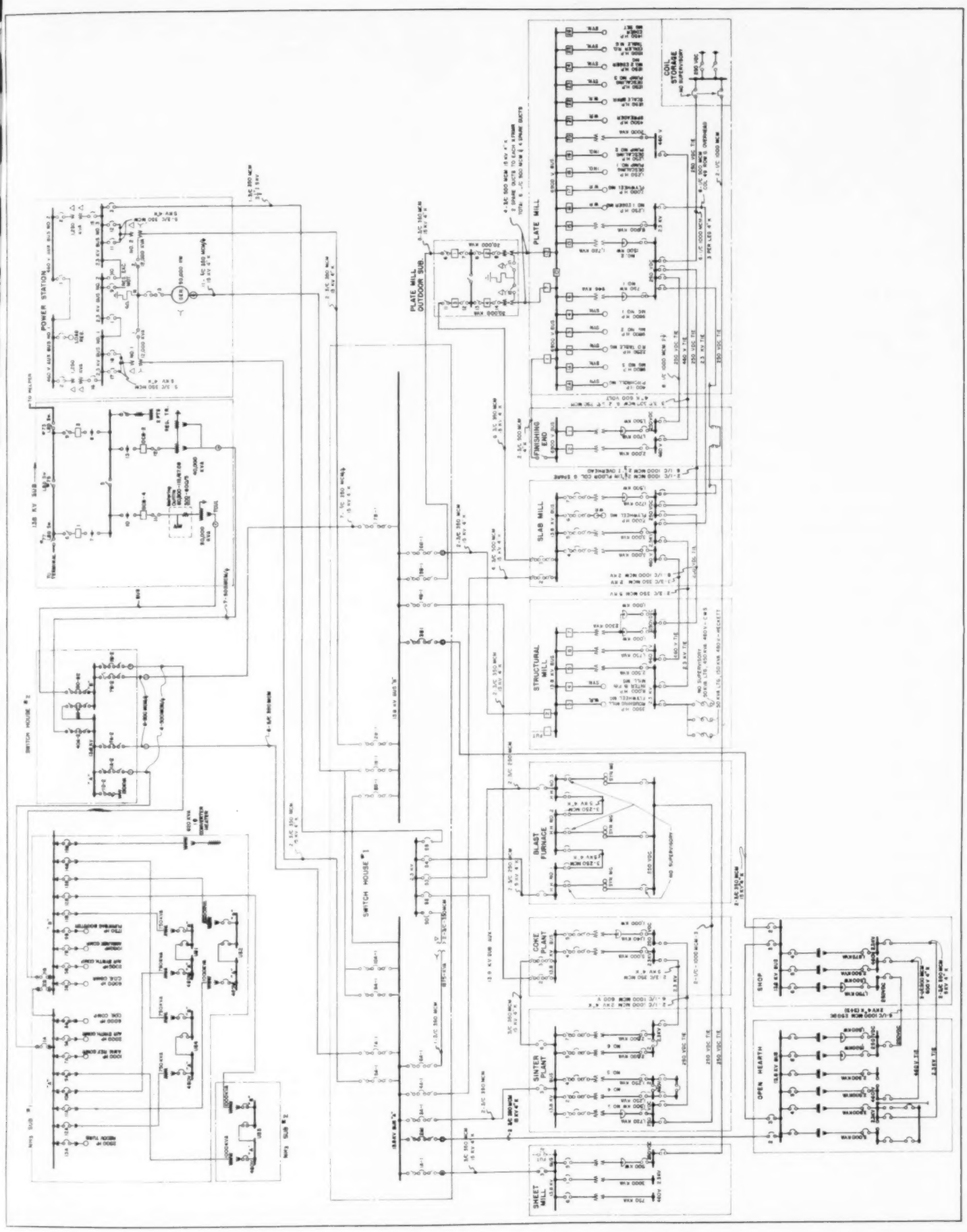
The turbine is arranged for steam extraction at the 7th, 9th, 11th and 14th stages for feed water heating.

The installation of one 50,000-kw unit instead of two 25,000-kw units was dictated by wartime conditions prevailing at the time of construction.

Generator output is governed by rotating field type load regulating equipment. This includes an initial pressure regulator, electric load regulator, turbine load control equipment, etc. To make turbine valves operate quickly this control operates the turbine valves from close to open in $3\frac{1}{2}$ seconds and changes generator load by as much as 12,500 kw per sec. This reduces excessive surges on the utility system.

Electric power is distributed to all major load centers at 13,800 volts. From the generator bus, cable feeders extend through underground ducts to seven major substations. Feeders consist of one or more 350,000 cir mil, three-conductor lead-covered cables or triplexed single-conductor cables.

The entire power supply and distribution system is supervised and controlled by a load dispatcher and a



Single-line diagram of electric power system.

TABLE III
Boiler Characteristics

Number	3	2
Capacity, lb per hr	300,000	150,000
Water heating surface, sq ft	22,270	12,536
Superheater surface, sq ft	7,720	5,100
Water wall surface, sq ft	4,790	2,542
Economizer surface, sq ft	4,420	3,800
Air heater surface, sq ft	25,600	7,700
Furnace volume, cu ft	19,100	9,600
Operating pressure, psi	475	475
Total steam temperature, F	760	760
Fuel	Blast furnace gas, CO gas, pulverized coal	Coke breeze, blast furnace gas

switchboard operator at the switch house. An independent supervisory control setup is provided for the interchange substation, coke plant, blast furnace, open hearth, slab, plate and structural mills, sintering plant, shops and sheet mill.

This system uses telephone type relays throughout and operates from a battery source of 48 volts d-c. Under normal operations, the operator of the supervisory control system actually operates remotely all motor-room and substation equipment. The substations are unattended. The load dispatcher also dispatches gaseous fuels, steam and water.

Each substation receives power at 13,800 volts and distributes it at 2300 and 460 volts a-c and 250 volts d-c to the area served by the station. An exception to this is the strip mill, where the operating voltage is 6900, again because of conditions prevailing at the time of construction. Direct current is produced by 12-tank, 6-phase rectifiers in each substation.

The plant sets up a 15-min demand of about 78,000 kw, and normally uses close to 45,000,000 kwhr per month, of which 90 per cent is generated in the plant and 10 per cent is purchased.

There are two separate steam systems in the Geneva plant, one of 450-psi pressure operating solely in the central power station, the other of 170-psi pressure supplying the coke plant, manufacturing processes and miscellaneous heating.

The high pressure system is supplied from five four-drum, bent-tube boilers, three rated at 300,000 lb of steam per hr, two at 150,000 lb per hr. Table III gives some characteristics of these units.

Furnace volume of these units was based on blast furnace gas firing at a heat liberation rate of 22,000 Btu per cu ft per hr. Gas is introduced through multiple intertube burners. Coke breeze is burned on 21 x 20-ft chain grate stokers.

The integral economizers are of drum and vertical tube design. Air heaters have vertical tubes.

Steam temperature is automatically controlled over a range from 60 per cent to full capacity.

Ash and dust are sluiced to a concrete tank and subsequently loaded into hopper cars for disposal.

The high pressure steam system serves the blast furnace blowers, the turbogenerator, evaporators to produce process steam and auxiliary pumps in the power station.

The 170-psi system is supplied from the waste heat boilers at the open hearth, with a stand-by supply available from the automatically controlled evaporators on the high-pressure system or, in emergency, from pressure-reducing desuperheating equipment.

Water is perhaps the one important requisite that Geneva does not have in abundance. Consequently, all possible steps are taken to conserve water.

Some water comes from artesian wells on the plant property. Of these, 14 are some 400 to 500 ft deep, five are 800 to 1200 ft deep. Additional water comes from the Provo River, either through the Lake Bottom and West Union Canals or by pumping from the river by two 5000-gpm pumps. This water is purchased from the Metropolitan Water District of Salt Lake City and flows from Deer Creek Reservoir.

There are three separate water systems in the Geneva plant: untreated, treated and domestic.

The untreated water system supplies blast furnace gas washers, sinter plant and pig machine cooling, mill roll cooling, scale flushing, etc. This water is pumped around the plant from a collecting basin by three 14,000-gpm motor-driven pumps. Pumping rate here is about 30,000-gpm, and the water is recirculated through several applications before being carried by sewers and ditches to Lake Utah. Makeup to this system is about 20,000 gpm.

The treated water system serves the coke plant, blast furnace cooling, open hearth cooling, reheating furnaces, condensers, etc.—all services where temperatures would cause scale troubles. Water for this system comes principally from the deep wells and is given a 2-ppm phosphate treatment, a sulphuric acid treatment to adjust pH value to about 8, and chlorine treatment to minimize slime formation.

This system is essentially a closed recirculating system, using a 1,000,000,000 gal reservoir that covers about 312 acres on the plant site. The water quality in the reservoir varies with depth and turbulence of water, plankton growth, etc. Hence, further treatment with acid or with copper sulphate is necessary from time to time.

Water flows from the reservoir to the powerhouse through a 9 x 12-ft intake tunnel. For condenser service there are two 26,000-gpm pumps and three 20,000-gpm pumps. Leaving the condenser, water flows through a discharge tunnel back to the reservoir. This recirculation amounts to about 110,000 gpm.

Also in the powerhouse are four 23,000-gpm pumps which put water from the reservoir through the plant treated water system. This water is also put through a number of uses before being returned to the reservoir. Rate of flow through this system is about 70,000 gpm.

Makeup to the treated water system varies with atmospheric conditions but averages about 10,000 gpm.

Water for boilers is taken from the deep well supply and put through a continuous cold softening plant, where it is treated with lime and sodium aluminate and then put through a zeolite softener. This water goes to the waste heat boilers and to the evaporators at the powerhouse. This amounts to about 1300 gpm.

Domestic water, about 1000 gpm, comes from three separate wells. Hardness is reduced some 60 per cent by passing a portion of the water through a zeolite softener and remixing it with that which by-passes the softener. This water is also treated with hypochlorite solution for bacteriological control and phosphate for corrosion control.

Waste water from all points served by the domestic

This central building houses the various shops and is well equipped to handle almost any maintenance job that might arise.

system is gathered by a sanitary sewer system and taken to a sewage disposal plant on the plant grounds.

Compressed air is provided from five separate spots. Four 1000-cfm compressors serve the open hearth and shop area; two 1000-cfm compressors serve the blast furnaces and their auxiliaries; one 200-cfm unit supplies the coke plant; two 500-cfm units are located in the powerhouse; and two 2200-cfm compressors serve the rolling mills.

Six acetylene generators are installed in a station near the rolling mills. The gas is piped around the plant at 10-psi pressure to consuming departments.

Oxygen for plant use comes as a by-product from the nitrogen products plant, supplemented by a liquid oxygen conversion unit. At present, oxygen capacity does not permit usage greater than about 200,000 cfm.

A central maintenance building houses blacksmith, machine, tool, welding, boiler and structural, pipe, rigger, carpenter, pattern, paint, instrument and electric repair shops. Because of the comparative isolation of the plant, these shops are large and well equipped to handle practically any job that might come up. The shops are lighted with fluorescent and mercury-vapor lights. A separate shop services rolling stock. In addition to these facilities, millwrights, pipe fitters and electricians assigned to definite departments have small shops of limited facilities in their respective areas.

Geography also dictates a rather complete spares program. An electrical spares storage building was recently completed to house spares for all major electrical equipment, spare exciter sets, etc. The building has air-conditioning and humidity control.

The plant railroad system is laid out so that all incoming shipments are received in a general yard and broken up for distribution throughout the plant. Also, all outgoing shipments are assembled in this yard. Thus, common carrier locomotives come only to this yard to deliver or take away strings of cars. All other movements are handled by plant locomotives.

MARTIN MATEKOVIC
Division Superintendent—
Transportation & Yards

There are approximately 101 miles of standard track within the plant. Motive power includes thirteen 120-ton and four 80-ton diesel-electric locomotives. There are also two 40-ton and one 25-ton diesel cranes, as well as some miscellaneous handling equipment and approximately 333 hopper, gondola, flat and dump cars.

Other units in the plant include a storeroom and spares yard; a garage housing fire trucks, ambulance, first aid truck and automotive repair shop; an industrial relations building housing personnel, safety, training and industrial engineering departments; a general office for supervision, engineering, accounting, production planning and raw materials; a dispensary fully equipped to treat employees injured or taken sick on the job, containing a first aid room, operating room, x-ray room and beds for temporary hospitalization.

IRONTON PLANT

The Ironton plant has been a pig iron producer since 1924. In 1943, a second blast furnace was installed. Because wartime conditions dictated speed in increasing iron production, and essential materials to build new plants were in short supply, it was decided to move an existing idle furnace from Joliet, Ill. Since this would be a complete separate unit, the stockhouse, boiler plant, blowing engines and buildings were also moved.

At present, Ironton has 56 by-product coke ovens and two blast furnaces. The plant is located on a 398-acre site 10 miles from the Geneva plant. It is served by the Union Pacific and the Denver and Rio Grand railroads.

Raw materials for Ironton are quite similar to those for Geneva and come essentially from the same sources.

Coal arrives at Ironton in hopper cars and is dumped into a track hopper, from where conveyors take it to the

hammer mill and onto a 750-ton storage bin at the ovens. Additional storage is piled on the ground, with coal handled in and out by bucket crane. The coal charged to the ovens is a mixture of high, medium and low volatile coals in respective proportions of about 76-12-12 per cent, pulverized so that 66 per cent passes through a ⅛-in. screen. Analyses of the coal mix as charged show approximately 36.39 per cent volatile matter, 57.96 per cent fixed carbon, 5.65 per cent ash, 0.73 per cent sulphur and 6.07 per cent moisture.

The ovens are arranged in two batteries, end to end. One battery is made up of 33 ovens, the other of 23 ovens, all of low differential, gun-flue type heated with coke oven gas. Ovens are 13 to 15½ in. wide, 42 ft-2½ in. long and 13 ft-2¼ in. high, and take a 14.7-ton coal charge.

The ovens are heated with coke oven gas, using 45 to 47 per cent of the total gas make. Flue temperatures run 2300 to 2350 F, wall temperatures 2150 F maximum.

The plant has conventional equipment for the recovery of tar, ammonia and light oil. At present, light oil is not fractionated at Ironton, but is sent to the benzol plant at Geneva.

Gas leaving the by-product plant flows to a 10,000-cu ft equalizing holder and then to a 1,500,000-cu ft holder. Surplus gas is used for boiler fuel, for sinter plant operation and for drying ladles and runners at the blast furnace.

Coke is sized by vibrating screens to give furnace coke plus 1-in., domestic coke 1-in. x ¾-in. coke breeze screened ¾ in. x ¼ in. and fine breeze minus ¼ in. Furnace coke runs about 59 per cent out of the coal weight. Some coke is also sent to Ironton from Geneva.

Iron ore comes to the plant daily in hopper cars. The ore is either dumped directly from car into the high line bins or, if necessary, is unloaded onto the ground by bucket crane. The high line bins have capacity for about 3500 tons of ore and 500 tons of limestone.

Ore fines and flue dust are sintered on a 72-in. sinter machine which is rated at 325,000 tons per year. About 35 per cent of the ore burden is sintered.

Dimensions and other pertinent data of the two blast furnaces are given in Table I. No. 1 furnace is the original Ironton furnace. No. 2 is the unit that was moved from Joliet.

Both furnaces have water-cooled cast iron stoves for hearth cooling, with copper cooling plates in the bosh and up into the inwall section. Alloy steel plates protect the stock line section.

Both furnaces are charged in the conventional manner. On No. 1 furnace, the skip hoist is operated by a steam engine and the bells by steam cylinders. No. 2 furnace has an electrically driven hoist and air cylinders actuate the bell hoists. Both furnaces have a rotating distributor top. No. 2 furnace is equipped with automatic charging control.

No. 1 furnace is blown by one of two turboblowers, each rated as 42,000 cfm at 25-psi pressure. Three reciprocating engines serve No. 2 furnace, providing a total capacity of 68,000 cfm at 28-psi pressure. A tie line connects the two blowing systems so that all blowers may be used on both furnaces.

Both furnaces are equipped with mixer valves to control blast temperature automatically. Furnace top temperatures range 300 to 325 F. Top pressure averages about 25-in. water column.

Gas is cleaned to a dust content of about 0.05 grain per cu ft by passing through a dust catcher, an orifice scrubber and a tower washer.

The furnaces produce basic iron, foundry iron and merchant iron for use in open hearths, foundry or merchant trade. No. 1 furnace is tapped every 4 hr-48 min, No. 2 furnace every 6 hr into 150-ton mixer type ladles or 68-ton open top ladles. Typical analyses follow:

	Basic	Merchant and foundry
Silicon	1.10	1.60–1.80
Sulphur	0.035	0.035
Phosphorus	0.39	0.21–0.32
Manganese	0.15	0.31–0.55

Iron may be sent to the Geneva plant over the Union Pacific railroad for use in the open hearth or in the mold foundry. If not shipped, it is cast into pigs on two double-strand pig machines.

Slag is tapped into ladles and put over a dump. Slag analyses average about as follows:

	Per cent
SiO_2	37.6
Al_2O_3	13.4
CaO	36.1
MgO	7.7
S	1.2
Fe	0.55
Mn	0.3

Electric power for Ironton is part generated, part purchased. Two 1500-kw turbogenerators supply power at 2300 volts, 60 cycles for all plant requirements except a 1000-hp fan motor at the sintering plant, which operates on purchased power. The generators are not tied into the purchased power supply. Purchased power is received at 44,000 volts and stepped down to 2300 volts by three 666-kva transformers and three 300-kva transformers. D-c power is supplied by two 300-kw synchronous motor-generator sets. A 50-kw turbogenerator in No. 2 boiler house also supplies d-c power.

Steam for the turbogenerators, coke plant and the turboblowers serving No. 1 furnace comes from six 617-hp, 230-psi, 100-F superheat boilers. All six burn blast furnace gas, coke oven gas or light oil, while two also have chain-grate stokers for burning coke coal. The steam generating capacity is 162,000 lb per hr.

Another boiler house serves the blowing engines on No. 2 furnace. This house contains five 1064-hp, 200-psi, 400-F boilers which burn blast furnace gas or oil. Three of these are also equipped with stokers. Steam generating capacity of this system is 250,000 lb per hr.

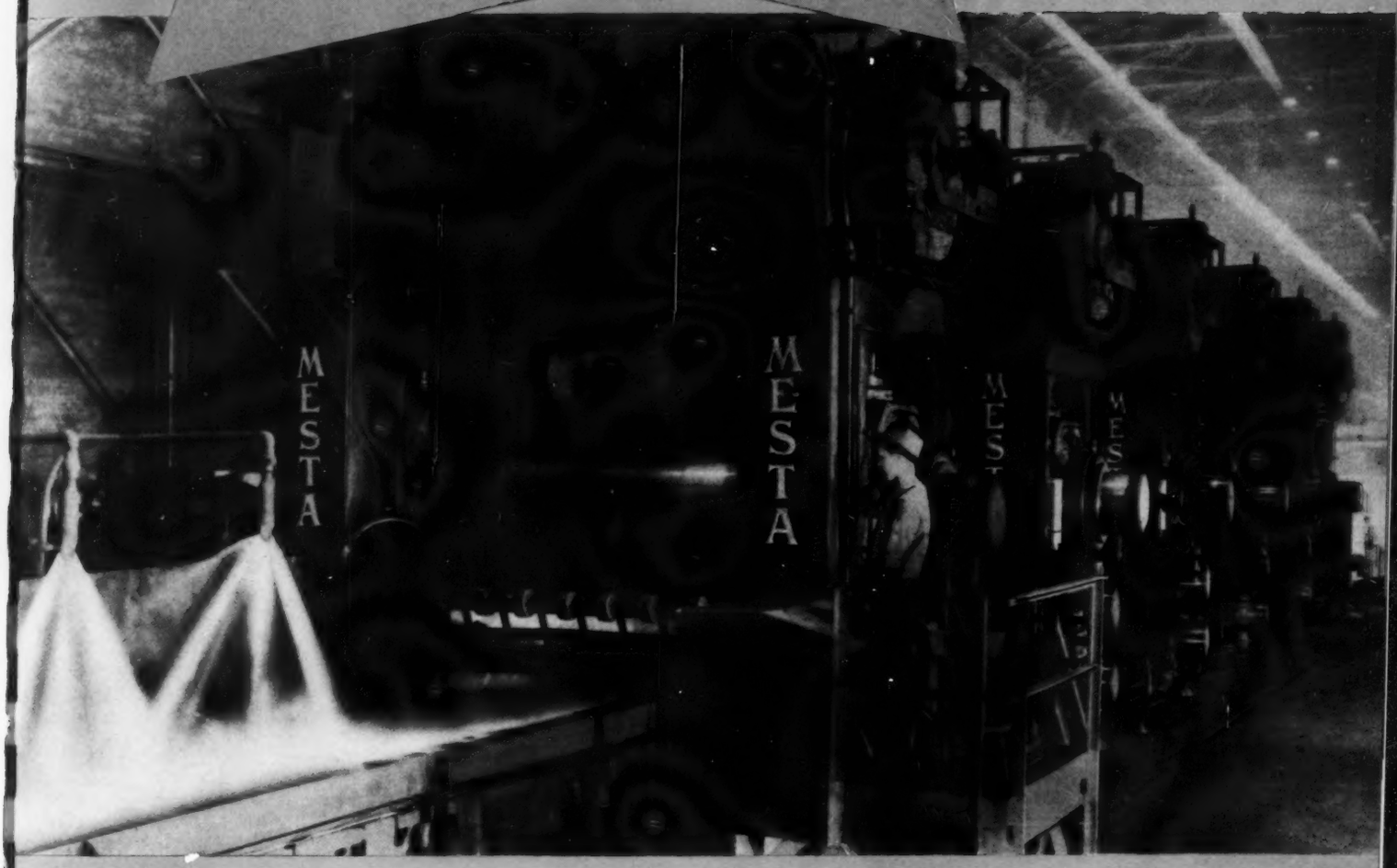
Water for Ironton comes from wells and from Spring Creek which originates in the mountains nearby.

* * * * *

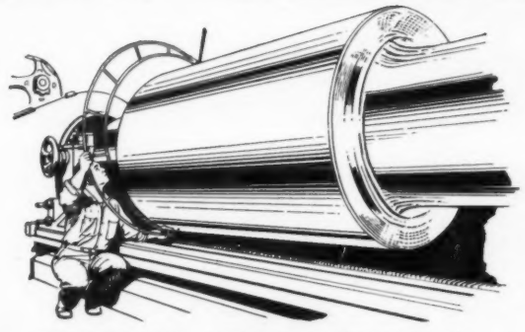
About 80 per cent of the jobs at Geneva Works are held by Utahans. Geneva has brought big industry to Utah, which has forgotten its early misgivings and has come to regard the industrial activity and its accompanying pay-roll as the blessing it is. Utah has adopted Geneva. Geneva will grow, and with it, Utah's economy.

MESTA

HOT STRIP MILLS



MESTA 132" FOUR-HIGH HOT STRIP MILL FINISHING STANDS
INSTALLED AT GENEVA WORKS
OF COLUMBIA-GENEVA STEEL DIVISION
UNITED STATES STEEL CORPORATION



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MESTA MACHINE COMPANY

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U.S. STEEL GETS MORE CHEMICALS OUT OF COAL

—from a pioneer plant that Blaw-Knox designed and built

Blaw-Knox builds pace setting nitrogen plant for Columbia-Geneva Steel Division of U.S. Steel Corporation. Over 400 tons per day of fertilizer and chemicals flow from the Intermountain area's first anhydrous ammonia plant, located near Provo, Utah. Shown from left to right: administration, maintenance, and compression buildings . . . ammonia synthesis, storage, and shipping . . . nitric acid production, ammonium nitrate production, prilling, packaging, and shipping.

No facility like this had ever been built before at a major American steel plant. Hydrogen, extracted from coke oven gas, is combined with atmospheric nitrogen using Montecatini processes to produce ammonia and nitric acid. For the first time in this country the famous Lurgi process is used for sulfuric acid production. The new plant also produces ammonium nitrate solids and solution.

Blaw-Knox had to construct cold boxes where temperatures drop to 300° below zero, and miles of complicated piping. Prilling towers 13 stories high are used.

For details on this and other pace setting projects, contact Blaw-Knox Company, Chemical Plants Division, 300 Sixth Avenue, Pittsburgh 22, Pa. Branch offices in New York; Chicago; Haddon Heights, N.J.; and Washington, D.C.

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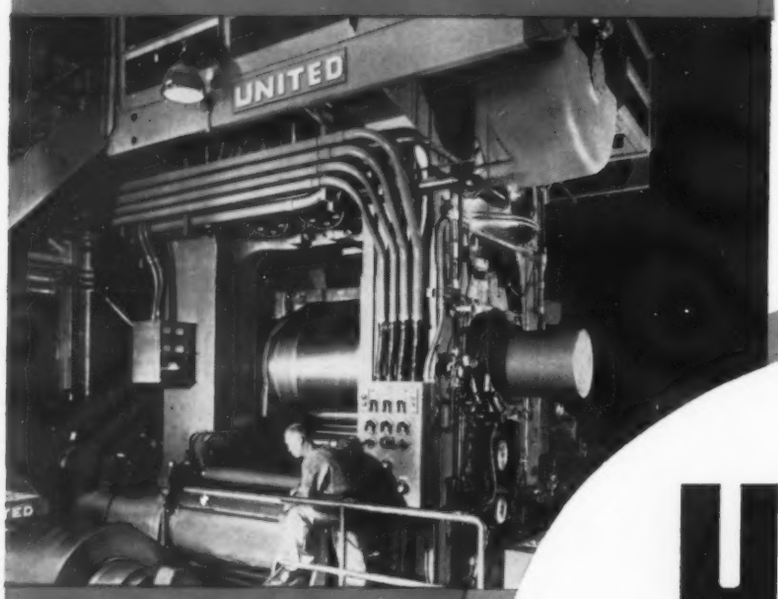

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UNITED 21″ & 53″ x 55″ 4 High,
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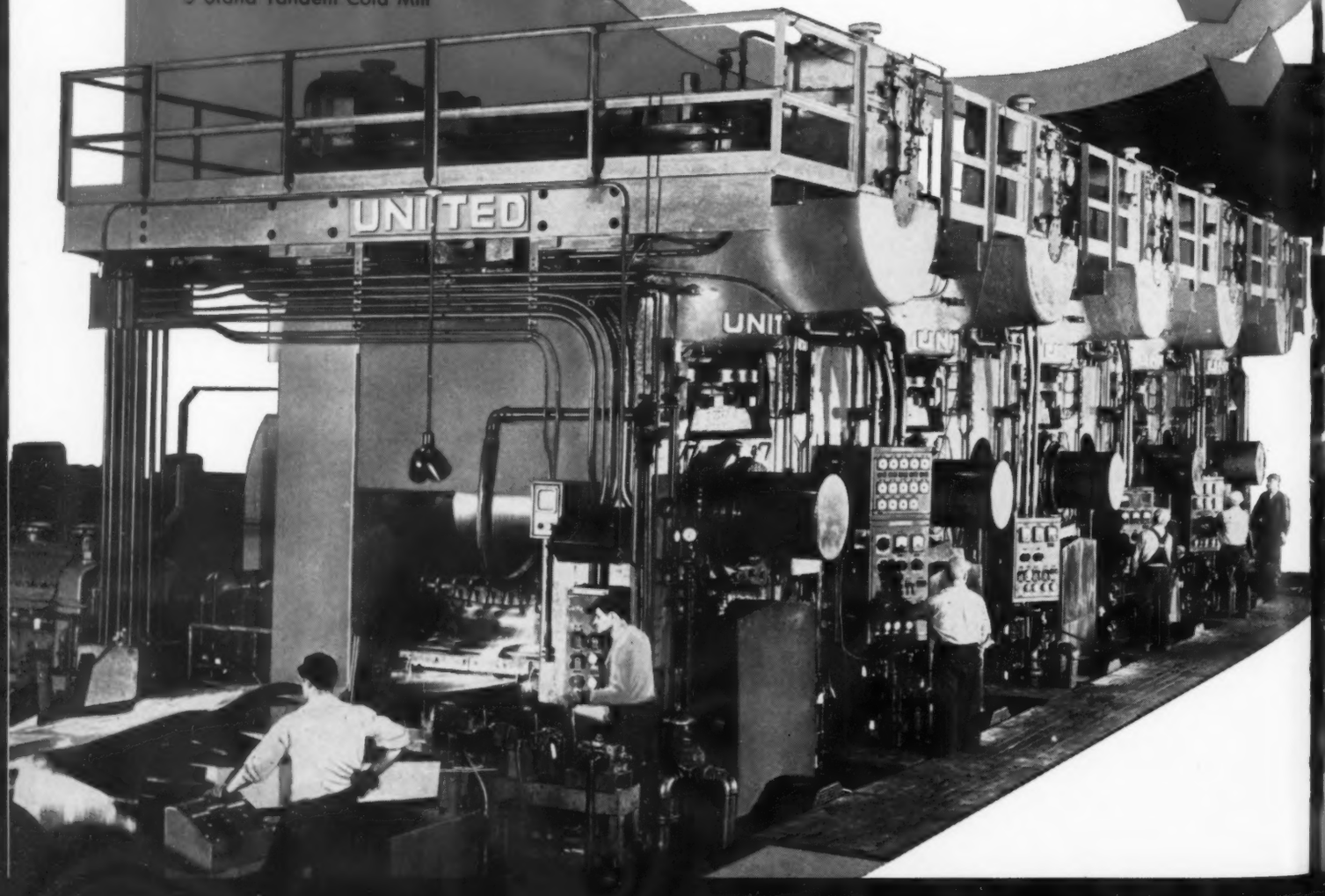
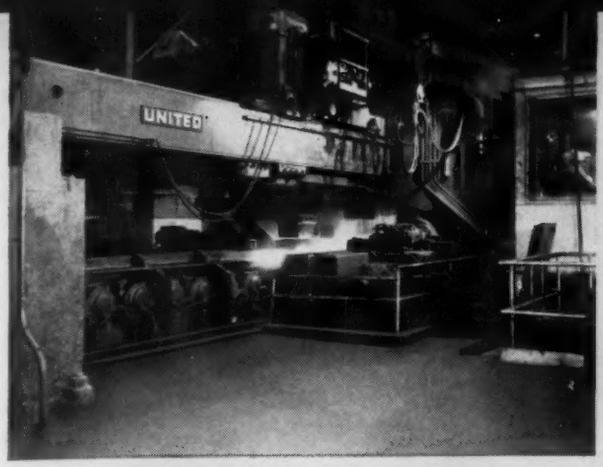
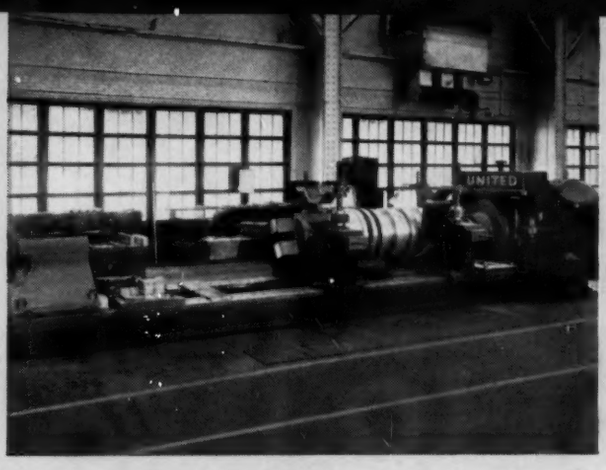


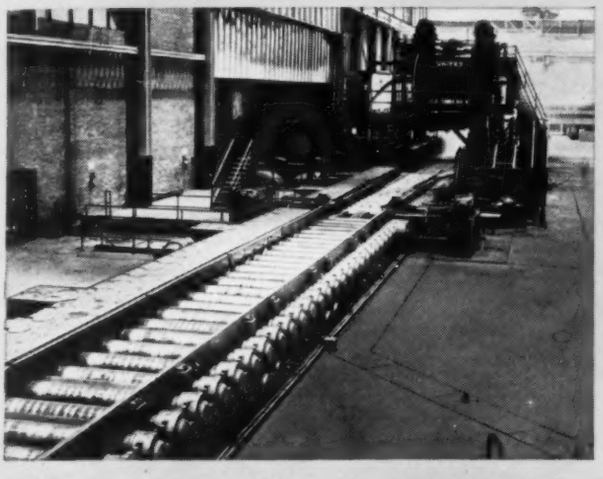


UNITED Shear Line



UNITED 50″ Heavy-Duty Roll Lathe

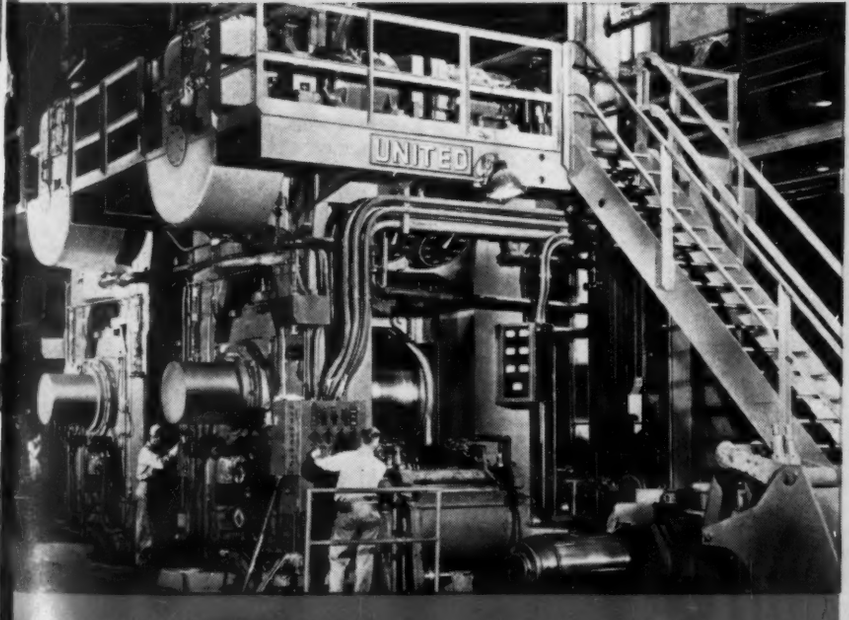
UNITED 45″ x 115″ 2 High Reversing Slabbing Mill



UNITED 32″ x 84″ 2 High Temper Pass Mill

COLUMBIA-GENEVA STEEL DIVISION

UNITED STATES STEEL CORPORATION



UNITED 18″ & 49″ x 42″ 4 High, 2 Stand Temper Mill

UNITED

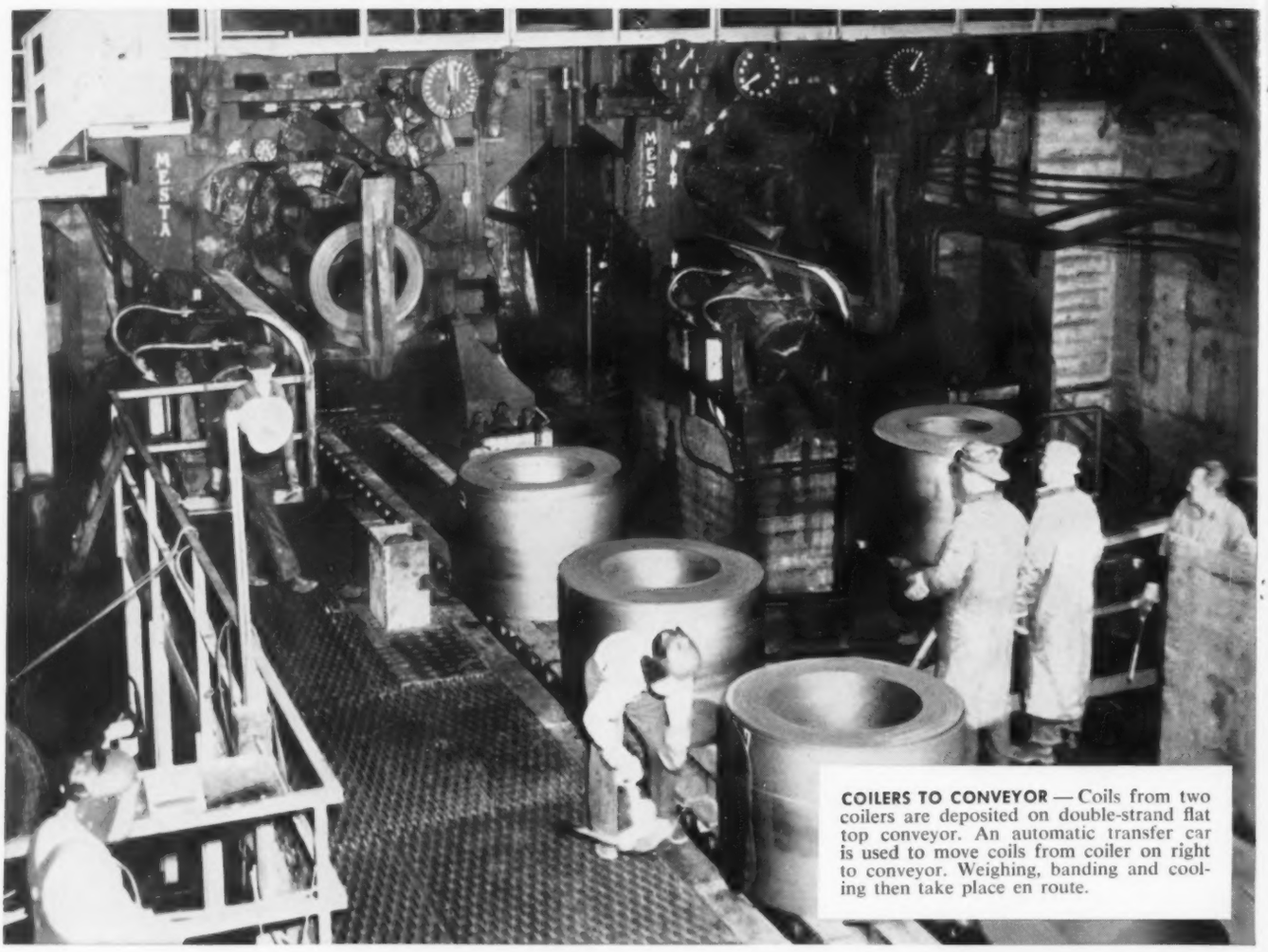
ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at—Pittsburgh • Vandergrift • Youngstown • Canton • Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.



COILERS TO CONVEYOR — Coils from two coilers are deposited on double-strand flat top conveyor. An automatic transfer car is used to move coils from coiler on right to conveyor. Weighing, banding and cooling then take place en route.

Lift, lower, tilt, turn, transfer, transport

Columbia-Geneva does it all on LINK-BELT coil conveyors

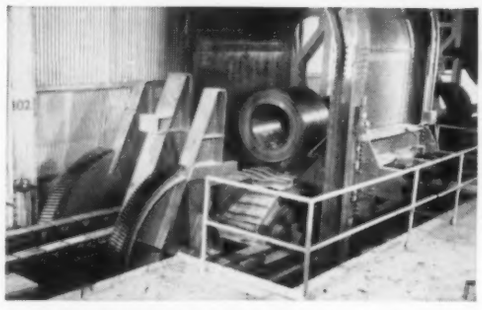
United States Steel's Geneva Works in Utah transports hot coils on Link-Belt coil conveyors. From coiler to coil storage, they provide the smooth, gentle handling necessary for maximum production . . . minimum scrap loss.

In your own mill—whether you require a single machine or a complete system, rely on Link-Belt to improve production and safety . . . reduce waste and effort. For further facts on both steel and bulk materials handling equipment, contact your nearest Link-Belt office. Or write for new Book 2764.

LINK-BELT

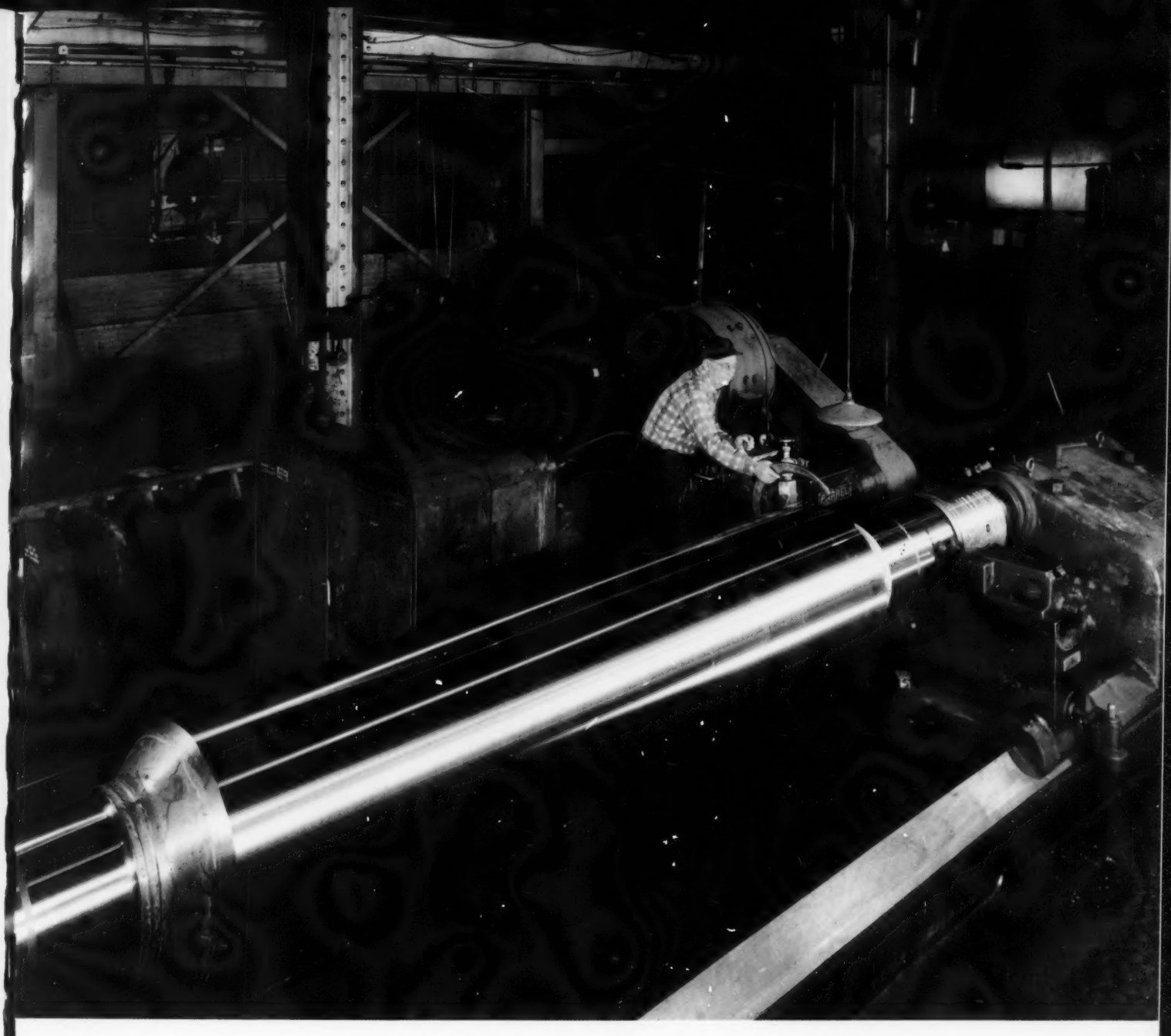
MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15.134



IN-LINE TRANSFER OF COILS — A unique transfer car with retractable carrying rollers shuttles coils from double-strand conveyor to special V-top banding conveyor via two downtilters—all without rolling.

DUMPING, TOO! In addition to furnishing a complete coil conveyor system, Link-Belt also supplied these two rotary car dumpers. One unloads coal for the coke plant while the other handles ore for blast furnaces and sinter plant.



NEXT STOP: Stand No. 6, finishing train

The glossy finish of this 35,800-pound Mack-Hemp Nironite F double-poured alloy iron work roll will soon be transferring itself to the quality hot rolled strip turned out by the 132-inch semi-continuous mill of Geneva Works of U. S. Steel Corporation's Columbia-Geneva Division, near Provo, Utah. This roll...like every one produced at Mack-Hemp...has been "custom-tailored" for the mill in which it is to serve. Tailored by Mack-Hemp's skilled foundrymen and roll turners at every step of the way through pattern making, alloying, pouring, machining and grinding. This, backed by the Mack-Hemp tradition of progressive metallurgy that is constantly developing new and better roll analyses, is why *you get more tonnage from the rolls with the striped red wabblers.*

MACKINTOSH-HEMPHILL • PITTSBURGH • U.S.A. • DIVISION

BLISS

MACKINTOSH-HEMPHILL • Division of E. W. BLISS COMPANY
Pittsburgh and Midland, Pa.

Citric Acid -- Dowell's New Service for Cleaning Stainless Steel Process Equipment

Now, for the first time, plant operators can be sure of a new degree of safety in the cleaning of their pressure units containing austenitic stainless steel—for example, heat exchangers, stainless-clad pressure vessels, atomic reactors, and supercritical-pressure steam generators. Citric Acid service by Dowell provides a new, effective method for these special chemical cleaning situations.

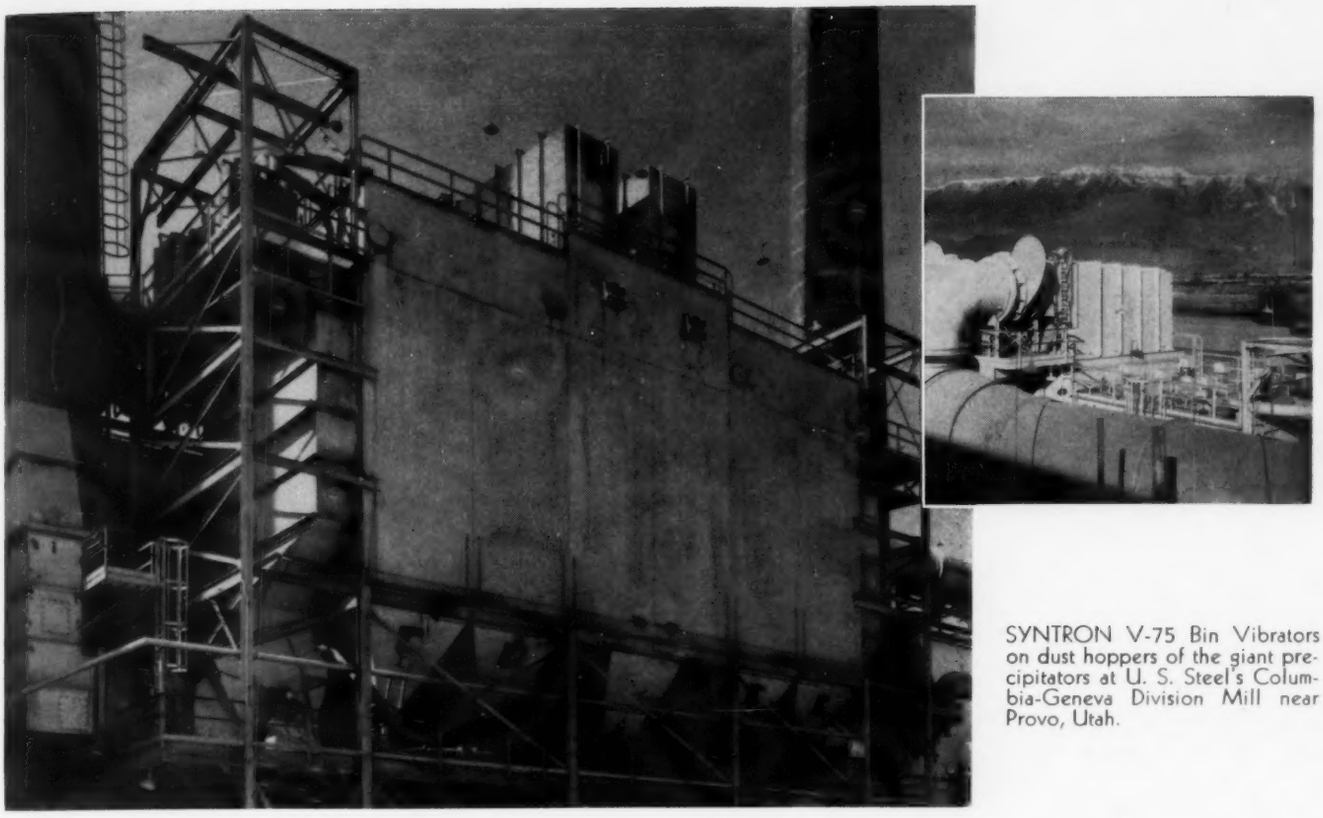
The Citric Acid used in Dowell chemical cleaning is inhibited with an *exclusive chloride-free* inhibitor. Cleaning with this new field-proven solution assures a chloride-free solvent system, and thus helps prevent chloride stress-corrosion cracking.

Dowell Citric Acid also provides other significant advantages: Citric Acid stabilizes dissolved iron and helps prevent precipitation of insoluble iron compounds when neutralizing chemicals are used. Flushing of the unit is not as difficult when Citric Acid is used. Citric Acid is especially suitable where stainless steel and other metals are used together in construction of the unit.

Citric Acid cleaning with a chloride-free inhibitor is just one of the new ideas from Dowell research. Other recent contributions include the new "white glove" standards of cleanness, copper removal agents and the new jetting device for cleaning heat exchanger tube bundles.

Ask your Dowell representative about Citric Acid service and Dowell chemical cleaning programs for your plant equipment. Dowell, the leader in chemical cleaning service and research, operates in every major industrial area through 165 offices and stations. Dowell, Tulsa 1, Oklahoma.

Chemical cleaning service for all industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY



SYNTRON V-75 Bin Vibrators on dust hoppers of the giant precipitators at U. S. Steel's Columbia-Geneva Division Mill near Provo, Utah.

SYNTRON BIN VIBRATORS and FEEDERS

contribute to the efficiency and economy of bulk materials handling at GENEVA Works of U. S. Steel

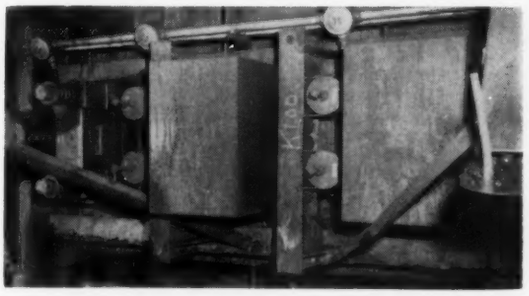
In the vast steel industry SYNTRON Bin Vibrators and Vibratory Feeders have varied and unlimited applications.

At U. S. Steel's Geneva Works SYNTRON Vibrators and Feeders are helping to increase production, improve safety and lower materials handling costs.

At this particular plant SYNTRON Bin Vibrators are used on the giant precipitators, on large dust collection hoppers and on the rotary car dumpers. SYNTRON Vibratory Feeders are used to control the flow of ore, coke, etc., from storage hoppers to conveyor belts, screens, ball mills, etc.

SYNTRON Vibrators and Feeders provide dependable, instantly controllable, high-frequency vibration (3600 vibrations per minute) that assures maximum flow of material with low operating and maintenance costs.

SYNTRON can solve many of your bulk materials handling problems.



SYNTRON V-500 Bin Vibrators on rotary car dumpers

SYNTRON Vibratory Feeder feeding coke to ball mill

SINCE 1921 SYNTRON EQUIPMENT of proven dependable Quality

Write for complete informative literature today

SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.

TSP in 'business'

"TOOL STEEL PROCESS" hardened products have been...in business...at the Columbia-Geneva Steel Division, United States Steel Corporation, for many, many years. Every division, from start to finish, has its share of TSP hardened products. Take a look at this list of TSP products used in their various divisions.

BLAST FURNACE DIVISION uses TSP herringbone shaft pinions and gears, spur pinions and gears, wheels, axles, couplings and shafts on ore reclaimers, cranes, rotary car dumpers and sintering plant equipment.

COKE DIVISION uses TSP gears and pinions.

OPEN HEARTH DIVISION uses TSP brake wheels, gears, pinions, rope drums, sheave and track wheels for ladle cranes, pit cranes, etc. Gears and pinions on charging machines.

ROLLING MILL DIVISION uses TSP miter and bevel gears, main drive spur gears, couplings for table drives. TSP spindles and coupling boxes on 26-inch structural mills. Gears, pinions, crane wheels, axles on all types of cranes, pins for coilers, screws and nuts for 45-inch blooming mill, all types of gearing for all equipment.

TRANSPORTATION DIVISION uses TSP pinions on diesel locomotives.

Every TSP product is specially hardened, resulting in a file hard surface to full depth of permissible wear. The core, refined for toughness and ductility, gives tremendous strength. That's why they last many times longer than ordinary products . . . that's why they reduce maintenance and replacement costs.

Write today — comprehensive literature tells you how TSP products can save money for you.

TSP Spindles and Coupling Boxes on 26-inch 3-high roughet and structural mills

TSP Gears, Pinions and Wheels on charging machines.

TSP Rotary Slitter Knives on No. 1 slitter.

TSP Table Gears and Manipulator Drive Gears on reversing mills

MEMBER OF AGMA

The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

at COLUMBIA-GENEVA STEEL

DIVISION OF UNITED STATES STEEL

TSP Table Gearing on structural mill hot bed.

TSP Gears, Pinions, Axles, Track Wheels, Brake Wheels, Sheave Wheels, and Rope Drums on overhead cranes.

TSP Gearing on crop shear entry table.

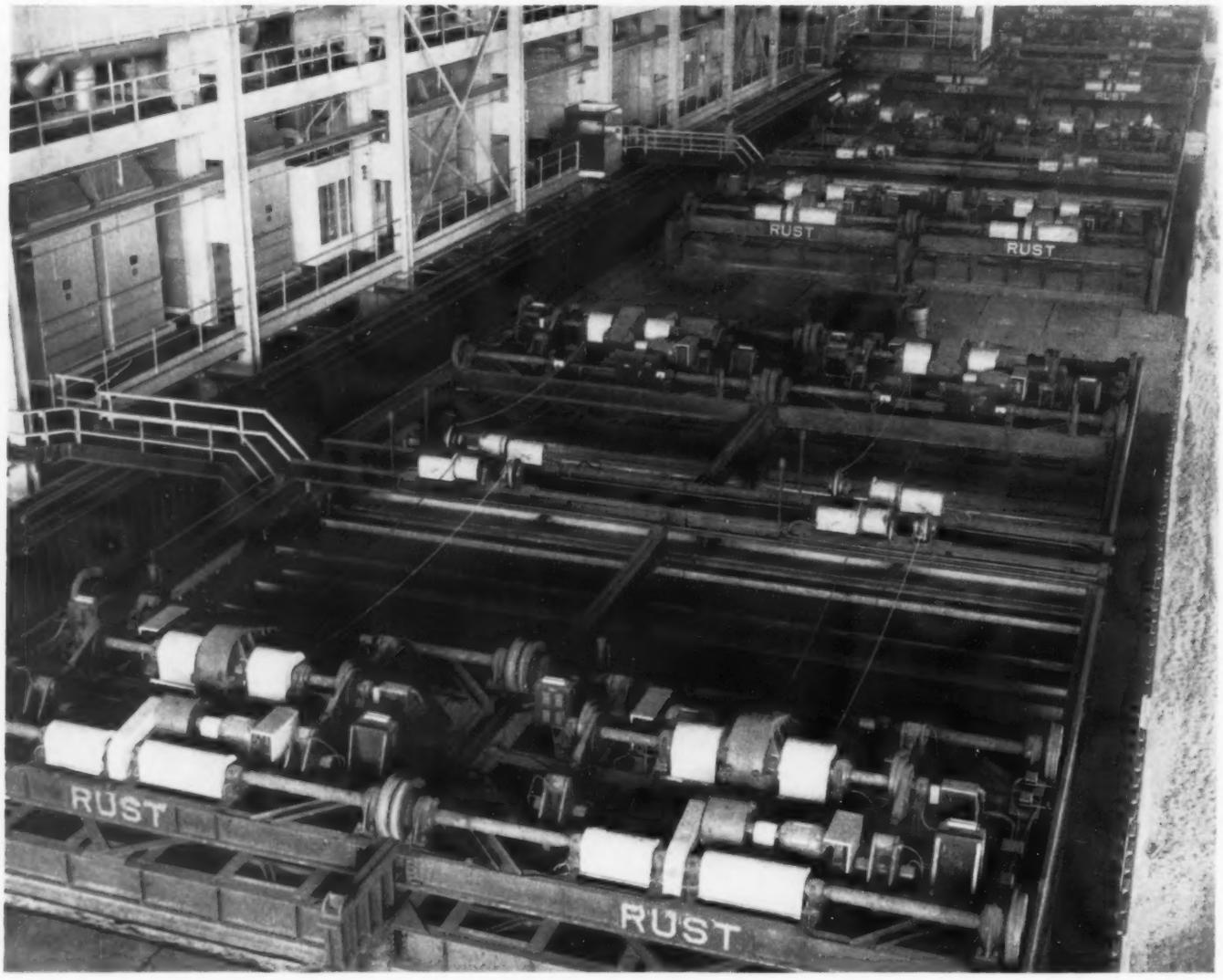
TSP Gears and Pins on down coilers.

TSP Gears on end shear depressing table.

TSP Screwdown Screws and Nuts, Manipulator Drive Gears, Couplings and Table Gears on 45-inch blooming and slab mills.

TSP Table Gearing and Overhead Crane Parts in finishing dept.

Morgan-Isley Systems WITH SECONDARY CHECKERS IN BASES OF EJECTORS



. . . Enable large Eastern Steel Plant to use 106 Btu per cubic foot mixed blast furnace and coke oven gas in sixteen holes of cross-fired regenerative soaking pits. Checker system preheats combustion air to 2000°F. or higher.

Simple, completely modern temperature and combustion controls with automatic reversal insure rapid, efficient heating with excellent uniformity from top to bottom of ingots.

This plant also has twenty-four other holes of soaking pits equipped with the Morgan-Isley System using 117 Btu per cu. ft. gas.

Morgan-Isley Systems are in use on soaking pits using the complete range of fuels from straight blast furnace gas up to and including natural gas and oil.

Modernize your soaking pits with Morgan-Isley — consult us about your requirements.

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MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS
ROLLING MILLS • MORGOIL BEARINGS • WIRE MILLS
GAS PRODUCERS • EJECTORS • REGENERATIVE FURNACE CONTROL
CCC 16

ASEA Pressductors are the heart of the Automatic Gage Control System for hot strip mill at Geneva Works, United States Steel Corporation, Provo, Utah.

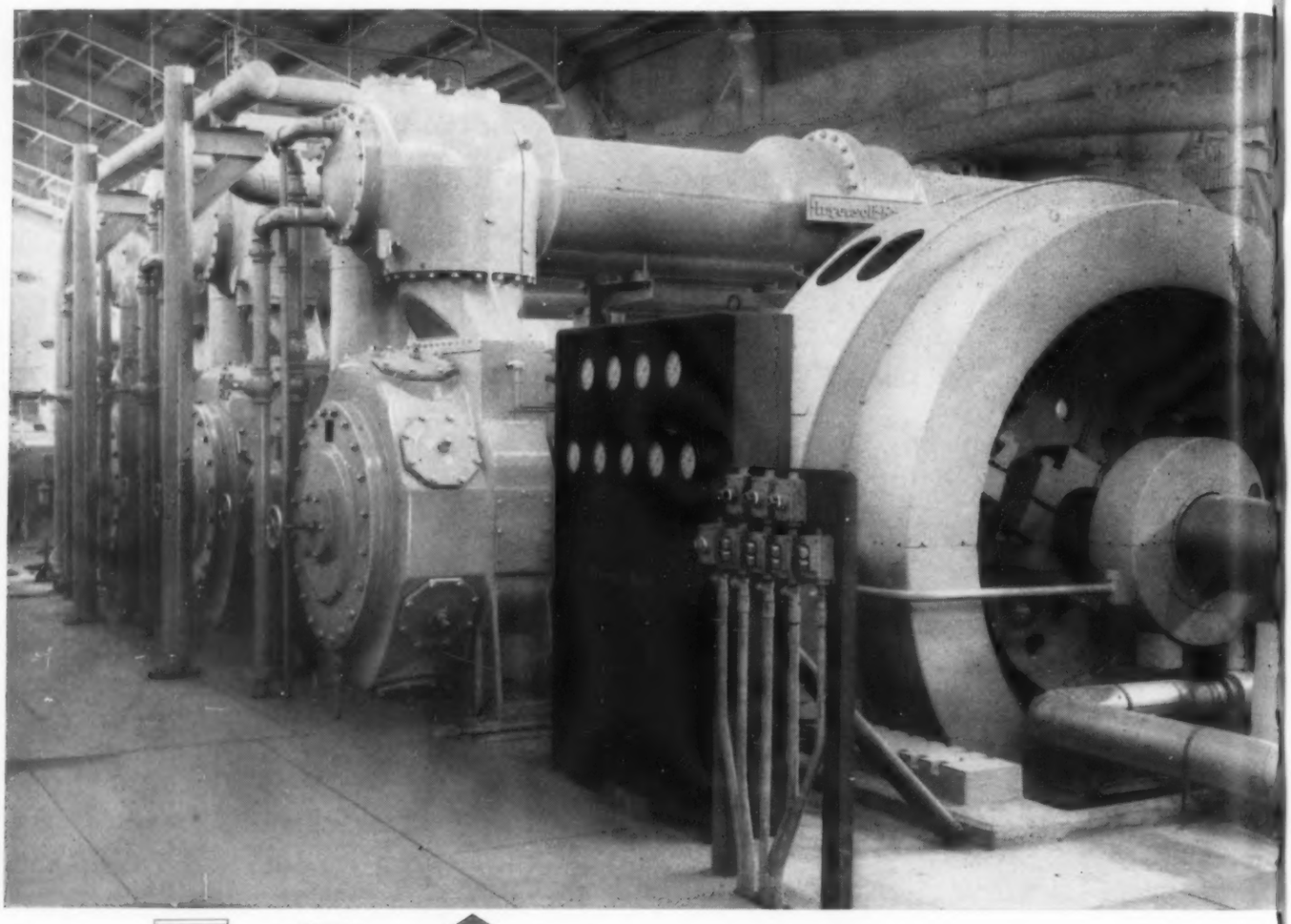
ASEA PRESSDUCTORS are especially useful for measuring and registering the heavy roll pressures in strip mills. At Geneva Works, they have met all of the extremely heavy demands of this type of installation. Slim design permits placement under the screw or under the bottom roll.

ASEA PRESSDUCTORS have high electrical output, are not affected by temperatures and have negligible hysteresis. For a detailed description of ASEA PRESSDUCTORS and their advantages to your applications, write:

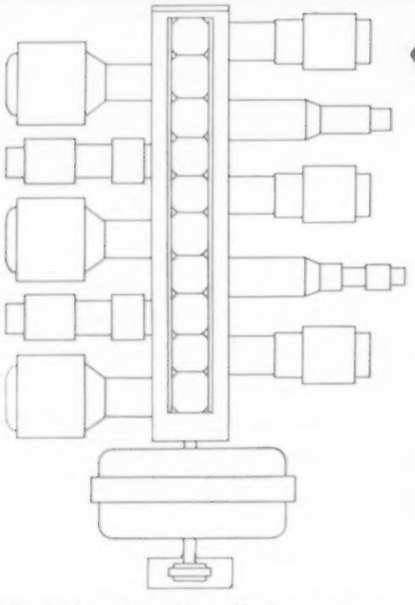
U.S. Sales and Service:

ASEA ELECTRIC, INC.
World Pioneer in Electrical Products for Industry
500 Fifth Avenue, New York 36, N. Y.

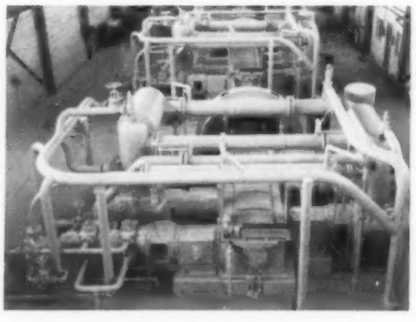
NATION'S LARGEST MOTOR-DRIVEN



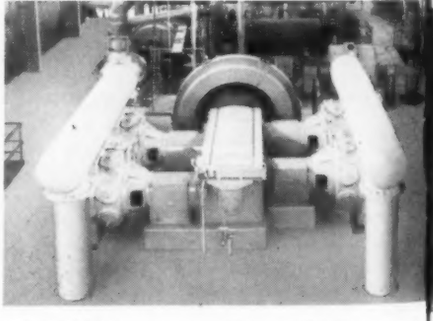
This is one of two ten-cylinder Ingersoll-Rand 6000-hp HHE compressors—the largest motor-driven reciprocating compressors in operation—on ammonia synthesis at the Geneva Works of Columbia-Geneva Steel, Geneva, Utah. Each unit simultaneously compresses coke-oven gas in two stages to 200 psi, and synthesis gas in three stages to 5300 psi. They are installed in the nation's first major steel-mill coke-oven-gas ammonia plant, engineered and constructed by Blaw Knox.



I-R design permits cylinder arrangement for best gas flow; three large cylinders handle coke oven gas in first stage, three in second stage. Others compress synthesis gas in three stages.



Above are two 2000-hp HHE's on air separation service. Each compresses oil-free air to 80 psi, and nitrogen in four stages to 2800 psi. The air cylinders are among the largest non-lubricated cylinders ever built.



This 1750-hp Ingersoll-Rand HHE compressor at the Geneva Works handles fuel gas (coke-oven gas after removal of hydrogen and carbon dioxide) for use in the steel mill. All of these HHE's are installed in the same building.

RECIPROCATING COMPRESSORS

Two 6000-hp Ingersoll-Rand units now in operation at Columbia-Geneva Steel's* NEW NITROGEN PLANT

*Division of U.S. Steel

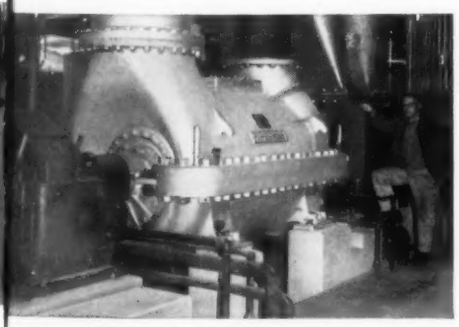
America's largest electric-driven reciprocating compressors are now at work in America's first steel-mill synthetic ammonia plant. Two ten-cylinder, 6000-hp Ingersoll-Rand HHE compressors—the first units of such size ever put into operation—are at the Geneva Works of U.S. Steel's Columbia-Geneva Steel Division in Geneva, Utah. The plant was engineered and constructed by Blaw Knox Company, and employs almost 20,000 hp of Ingersoll-Rand compressors, both reciprocating and centrifugal.

Big process jobs like this one require heavy-duty compressors that are *engineered* to the job. Compressors of this magnitude are not "off-the-shelf" items. At Ingersoll-Rand, each HHE compressor is carefully engineered from the ground up to fit the needs of its particular job.

First of all, the proper compressor cylinders are designed. They have to be of the right size, type and materials to suit the volumes, pressures and gases involved. No one can match the wide range of compressor cylinders built by Ingersoll-Rand, and the correct valving is assured by I-R's own valve design and manufacturing departments.

The cylinders must be arranged on the frame in the best sequence, and at the same time the crankshaft is *specially* designed for best running balance, smoothest torque and smoothest gas flow. These Ingersoll-Rand methods of *individual project analysis* have been proven in hundreds of process installations.

The world's most comprehensive compressor experience, in process *and* all other compressor applications, is offered by Ingersoll-Rand. Contact your I-R representative or write now for more information on HHE and other compressors for process services.



This 2800-hp I-R centrifugal compressor handles air for ammonia oxidation. The hot nitrogen from this reaction goes through an I-R expander—a power recovery turbine—which helps to drive the compressor itself.

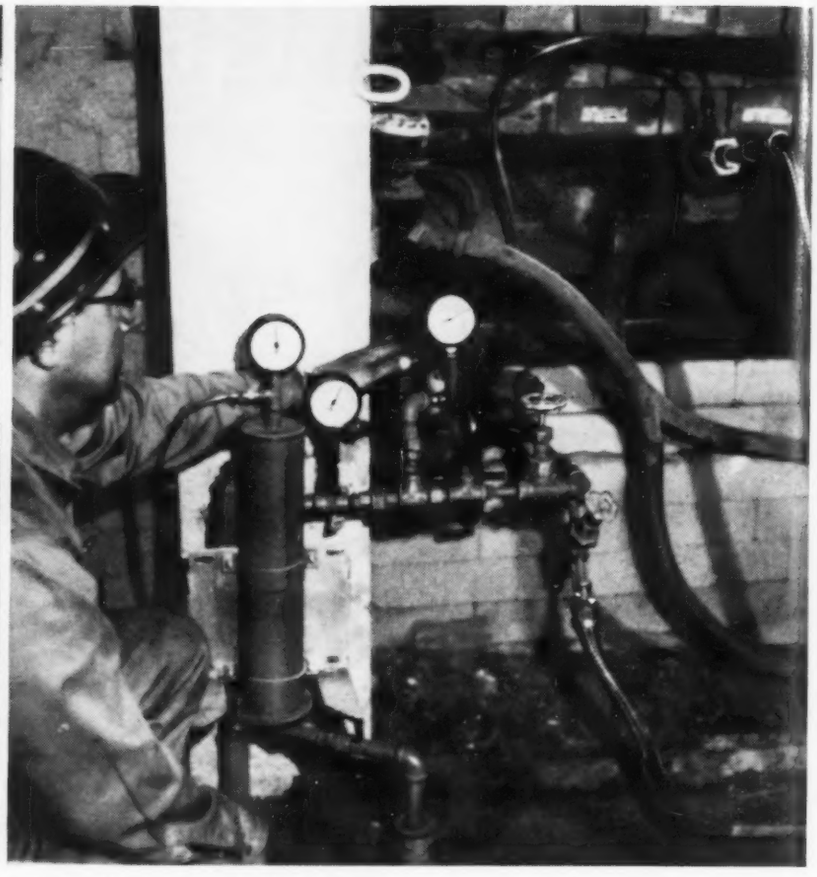
Ingersoll-Rand

I-722 11 Broadway, New York 4, N.Y.

COMPRESSORS
VACUUM EQUIPMENT
ROCK DRILLS
GAS & DIESEL ENGINES

CONDENSERS
AIR & ELECTRIC TOOLS
PUMPS
TURBO-BLOWERS

O_2 Analyzer at Pittsburg, Cal. Works



Exclusive L&N Steam Jet Sampling System

New Trend in Open Hearth Combustion Control

Columbia-Geneva modernizes with continuous O_2 analysis

As fast as budget and operating conditions permit, open hearth furnace operators are switching to accurate, dependable Leeds & Northrup Oxygen Analyzing and Control Systems for improved O-H combustion practice. At over 70 installations, superintendents are anticipating increased roof life, lowered fuel costs and shorter heats.

Typical of complete installations of this industry-proved equipment are those at three plants of Columbia-Geneva Steel Division, United States Steel Corporation. There, 19 L&N systems have been in operation, some since early 1957, providing automatic control of exit gas O_2 content . . . speeding heats and lowering Btu requirements.

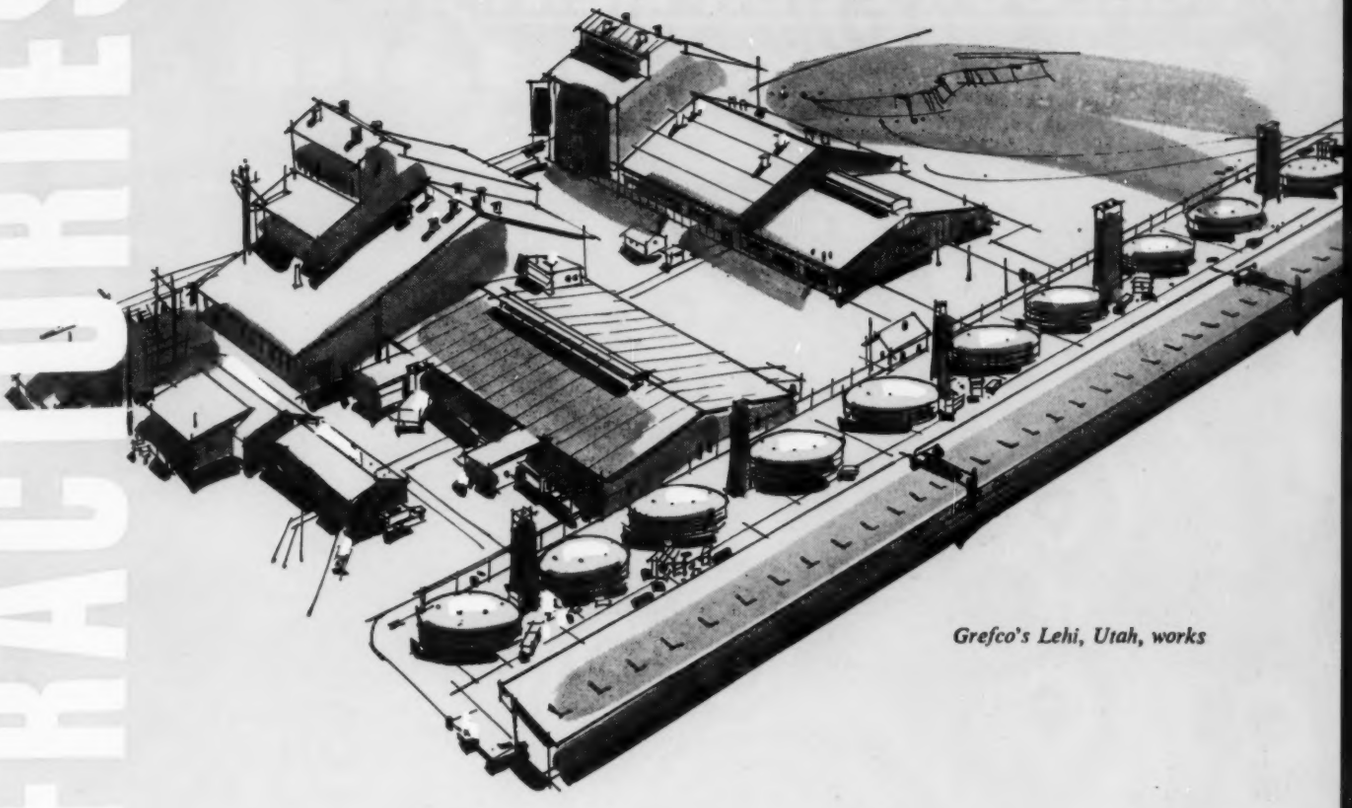
These systems operate directly from Leeds & Northrup Magnetic Oxygen Analyzers. Continuously sampling the oxygen content of waste gas, the Analyzers supply a signal to Speedomax® recorder-controllers. The control systems, in turn, operate to adjust louvers on the forced air fan, or control fuel directly to maintain the desired oxygen content in the waste gas.

And at all installations, the L&N Magnetic Oxygen Analyzing equipment is providing a stable, accurate measurement, fully compensated for background gases, without flammable auxiliary gases. The exclusive L&N Steam Jet Sampling feature assures that a clean sample is continuously delivered under pressure to the Analyzing Unit.

Ask your nearby L&N engineer about this important trend in open hearth combustion practice. He can give you facts and figures about how others have profited from this equipment. Call him, or write 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

GENERAL REFRACTORIES



Grefco's Lehi, Utah, works

GREFCO BRICK PLAY KEY ROLE IN U.S. STEEL'S GENEVA PLANT IMPROVEMENT

Since mid-1958, the Geneva, Utah, works of U.S. Steel's Columbia-Geneva Steel Division has undergone a continuous improvement and modernization program.

Just a few miles away, General Refractories' strategically-located Lehi works supplies clay and silica brick to the Geneva works. From other GREFCO factories East and West come other GREFCO brick, such as steel-encased Steelklad-EE, used in Columbia-Geneva's progressive program of conversion to all-basic open hearth steel production.

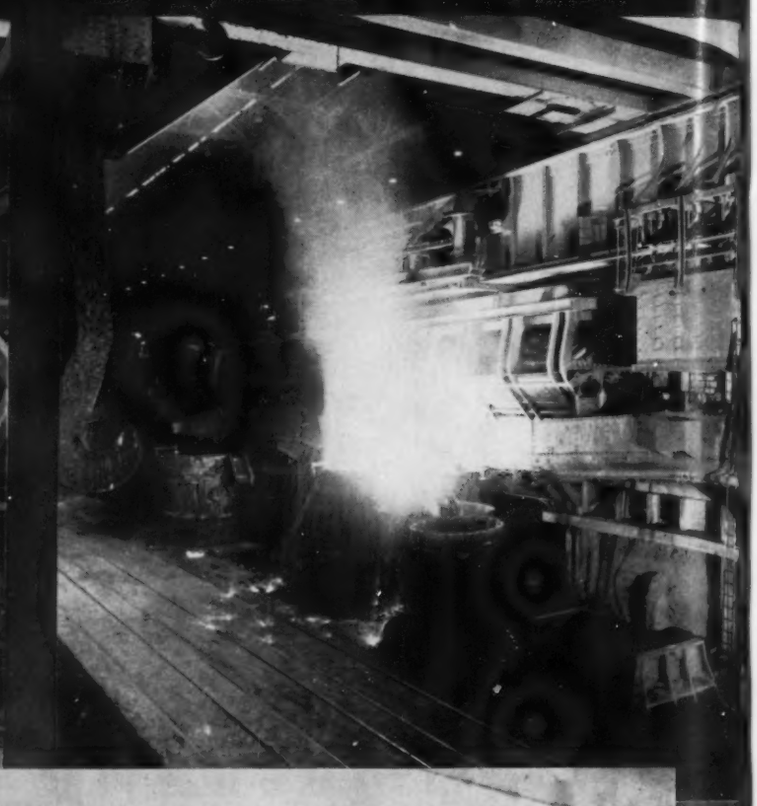
Such plant-to-plant teamwork is another example of GREFCO's ability to supply the world's best refractory products, in a great variety of specialized types, promptly and dependably, to any location on the map.

Call your nearest GREFCO Representative and prove it to yourself!

GENERAL REFRACTORIES COMPANY
PHILADELPHIA 2, PA.

GREFCO

IRON and STEEL *MOVES* in POLLOCK EQUIPMENT at GENEVA WORKS - U. S. STEEL CORP.!



At U. S. Steel's Geneva, Utah Works hot metal MOVES from blast furnace to open hearth in Pollock Mixer Cars . . . from stationary mixer to open hearth furnace via Pollock Transfer Ladle Cars . . . and from open hearth furnace into ingot molds via Pollock Ladles.

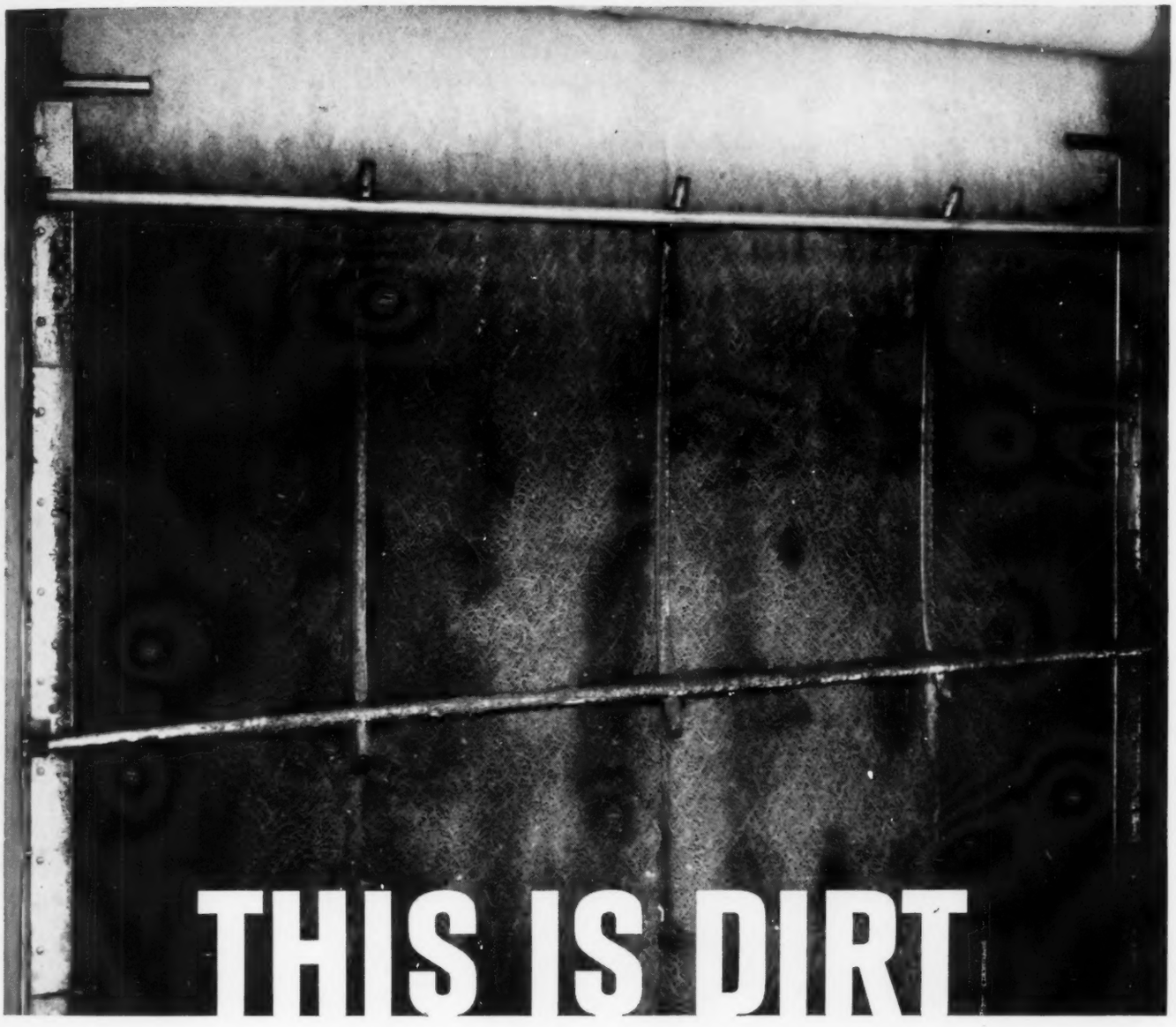
POLLOCK - a standard in iron and steel handling equipment for over 95 years. Buy best! Buy Pollock!

POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO
Associated in Great Britain with Ashmore, Benson, Pease & Co.

ENGINEERS, FABRICATORS AND ERECTORS OF BLAST FURNACE STEEL WORK . . . HOT METAL AND SLAG HANDLING EQUIPMENT FOR . . . BLAST FURNACE, OPEN HEARTH AND ELECTRIC FURNACE PLANTS

THIS IS AN AAF AIR FILTER*



that can never get to COLUMBIA-GENEVA'S electrical equipment

Dust and dirt—the arch enemies of steel mill electrical equipment—don't have a chance at U. S. Steel's new Columbia-Geneva Division Mill at Geneva, Utah. AAF was called on to make sure of that.

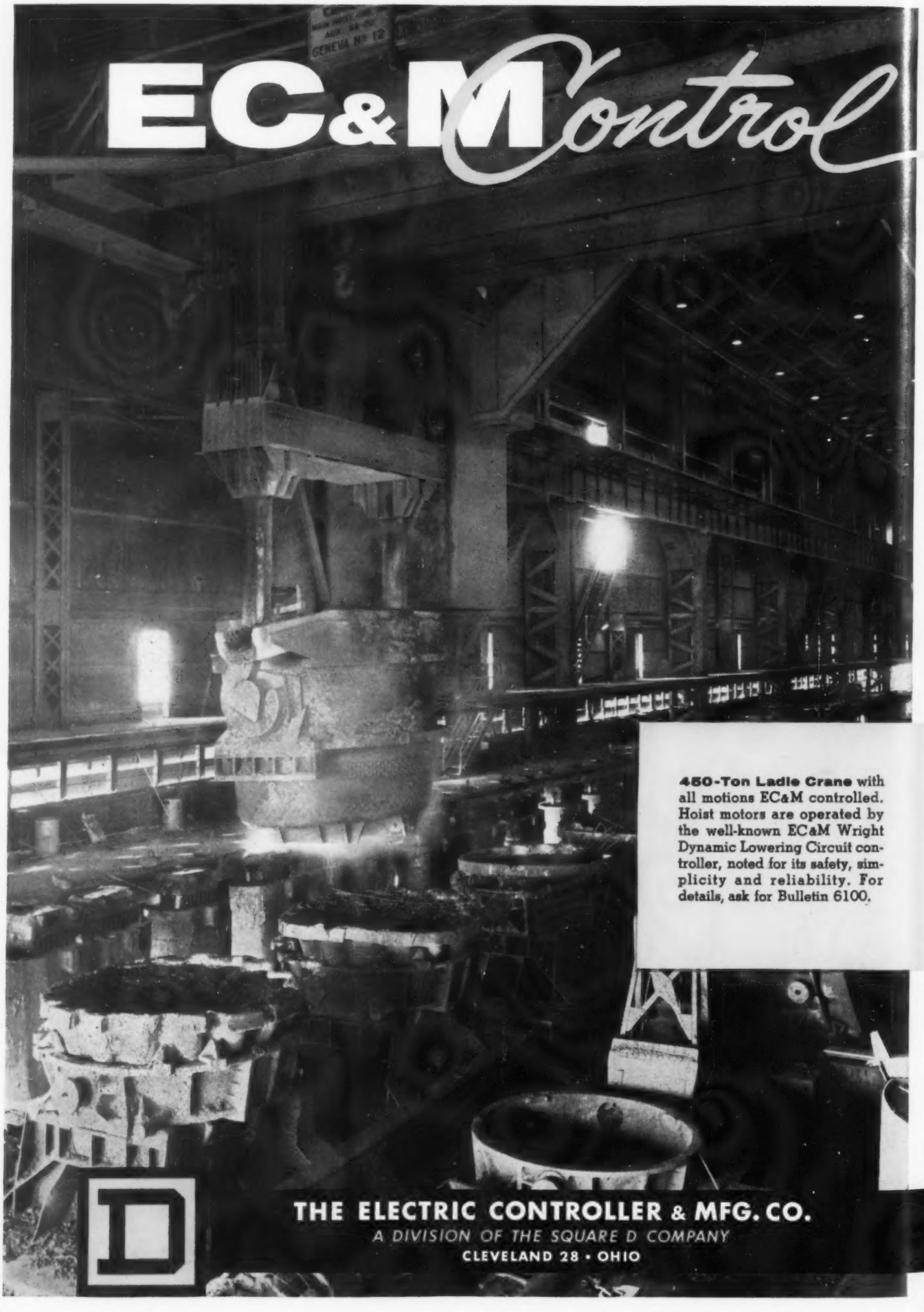
Six different types of filters were required to handle all the clean-air needs at Columbia-Geneva. AAF is uniquely able to meet *all* air-cleaning needs because only AAF makes *all* kinds of air filters. Ask your local AAF representative for Bulletin 518 or write us direct. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Kentucky.

*AAF Roll-O-Matic renewable-media air filter.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

EC&M Control



450-Ton Ladle Crane with all motions EC&M controlled. Hoist motors are operated by the well-known EC&M Wright Dynamic Lowering Circuit controller, noted for its safety, simplicity and reliability. For details, ask for Bulletin 6100.

THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

tames the giants at Columbia-Geneva!

GIANTS AT WORK... keeping a tight rein on the toughest and most exacting operations at the Columbia-Geneva Works of United States Steel Corporation is the responsibility of EC&M control. Here, at Geneva, as well as throughout the metal-producing industry, EC&M control apparatus and engineering have earned a reputation for safe, reliable performance in basic steel making.

EC&M control is built to meet the rigid demands of open hearth and rolling mill departments. For cranes, charging machines and mill auxiliary drives, EC&M control equipment is unexcelled.

Operator's pulpit, overlooking the 132" reversing-rougher, contains EC&M Slider-Contact panels for automatic-positioning of horizontal and vertical rolls. Slider-Contacts may be moved up or down to change to new rolling schedules or to make minor adjustments quickly when rolls are changed. Roller operates a single push button to produce products rolled to accurate tolerances. For complete facts, write for Bulletin 6550.

EC&M 65-inch Type SW all-welded lifting magnet on overhead crane successfully withstands wide temperature changes in handling crop-ends from cooling pits. Bulletin 1300 describes EC&M lifting magnets for steel mill service.

The tough service encountered on charging machines is the acid-test of EC&M control. Here, highly repetitive operation under maximum loading brings out the long-life qualities of EC&M Line-Arc magnetic contactor control.

FOR BASIC STEEL MAKING, IT'S EC&M CONTROL

3125

Growing With The Industrial West!

serving the steel industry

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— PIPING —

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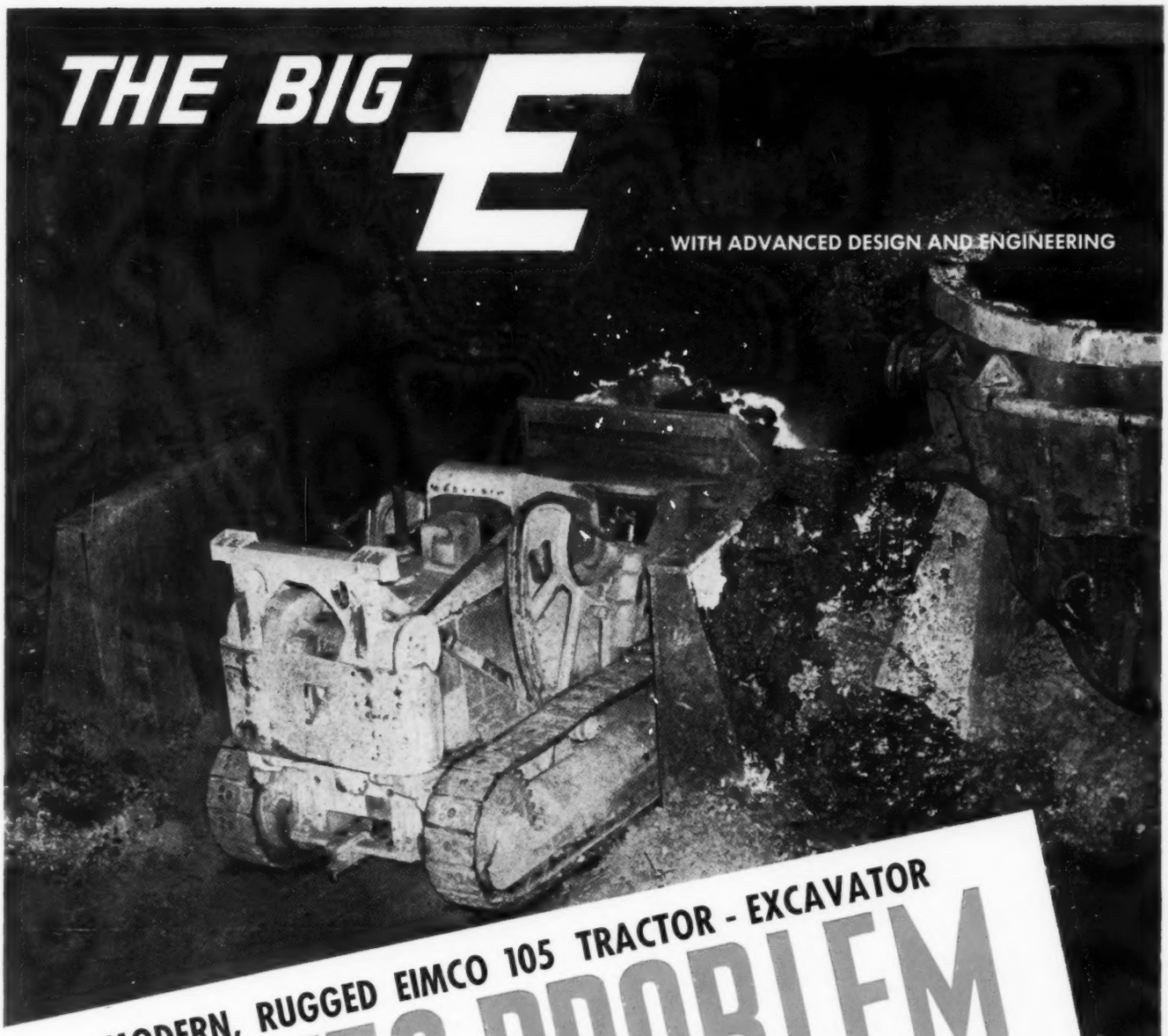
Fred I. Childress, President and Manager

THE BIG E

. . . WITH ADVANCED DESIGN AND ENGINEERING



MODERN, RUGGED EIMCO 105 TRACTOR - EXCAVATOR

SOLVES PROBLEM

AT GENEVA WORKS • • • • •

When slag pockets, in a solid mass and big chunks, form at the Open Hearth, you have a problem! U. S. Steel Corporation's Columbia-Geneva Steel Division in Utah, considered many methods for breaking up this hot, tough mass. Equipment was tried, and failed either in break-out strength or proved incapable of withstanding, for any length of time, the fierce heat generated by the slag pile and its abrasive action.

The problem was solved when an Eimco 105 Excavator was put to work. It's modern power-train of powerful diesel engine, torque conver-ter, exclusive 'Unidrive' and dual final drives, created an irresistible pull or push, capable of breaking up the hot, tough slag mass into small, loadable pieces. It's overhead loading action made for efficient loading-disposal. Eimco's rug-ged construction and quality craftsmanship shrug-ged off the heat and the beating a machine takes on this tough assignment

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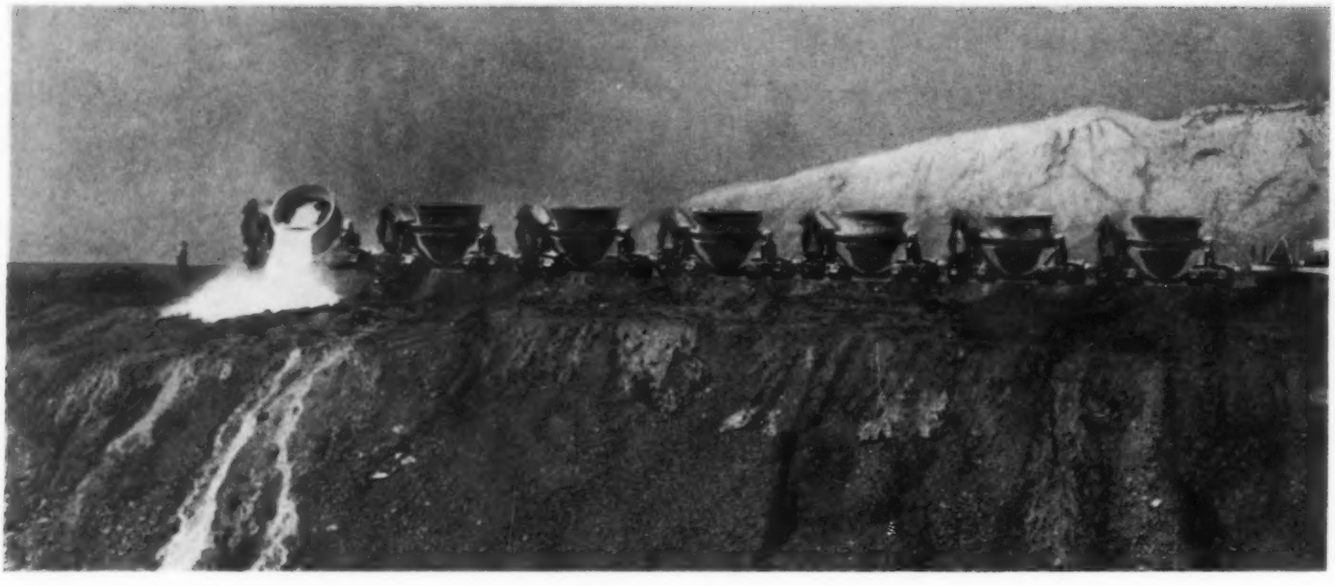
At Geneva Works, Utah



27 Treadwell cinder cars

These Treadwell 400-cubic foot cinder cars were photographed in operation at the Geneva Works of Columbia-Geneva Steel Division, United States Steel Corporation. In all, 27 of these cars are used to transport blast-furnace slag. Each is automatically dumped by compressed air—requiring no crane. Four Treadwell mixer-type hot-metal cars are also in service at this mill.

Treadwell can build any type of cinder car needed in today's steel plants. Optional designs include one to four pots . . . air or electric dumping . . . cast or welded steel construction. Crane-dump cars can also be supplied.

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United States Steel Corporation

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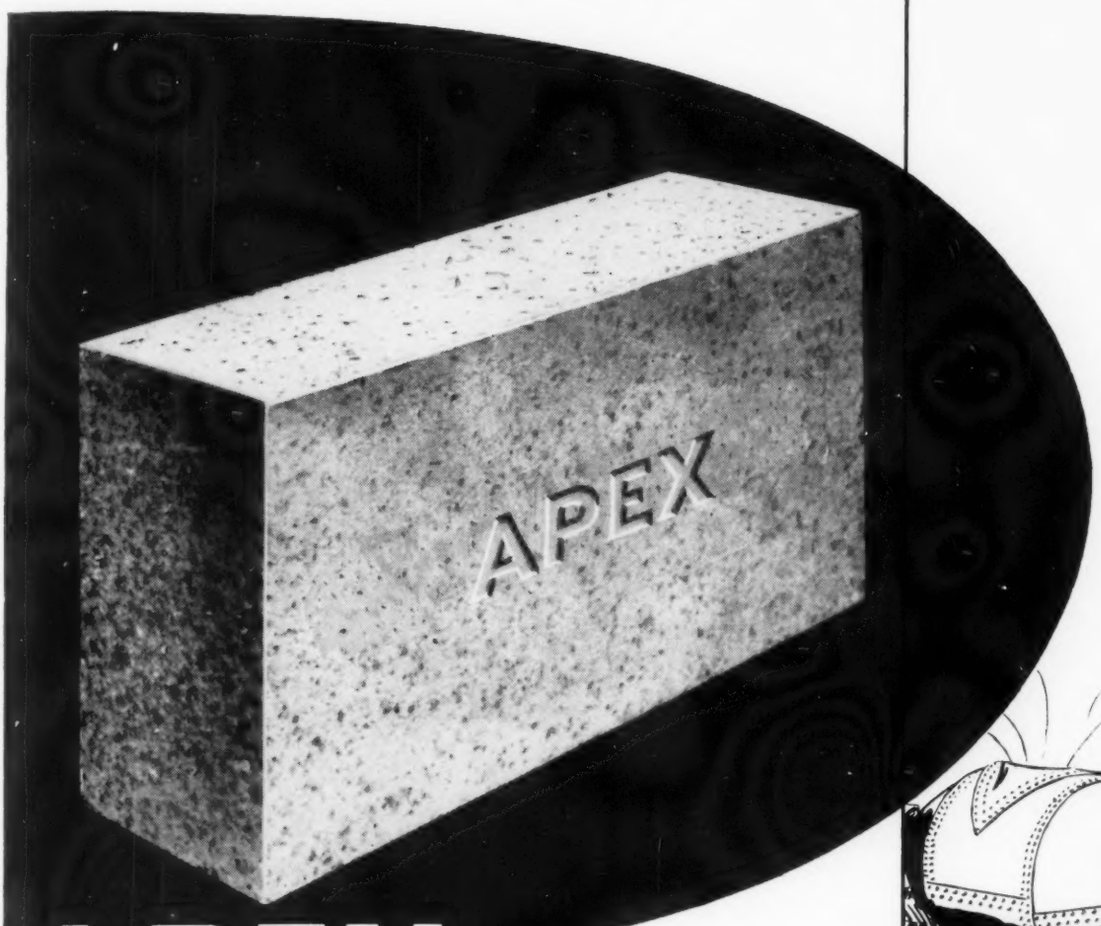

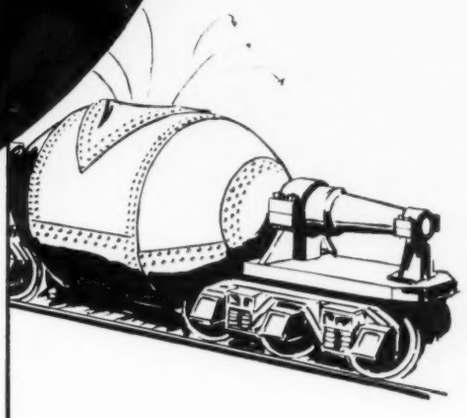

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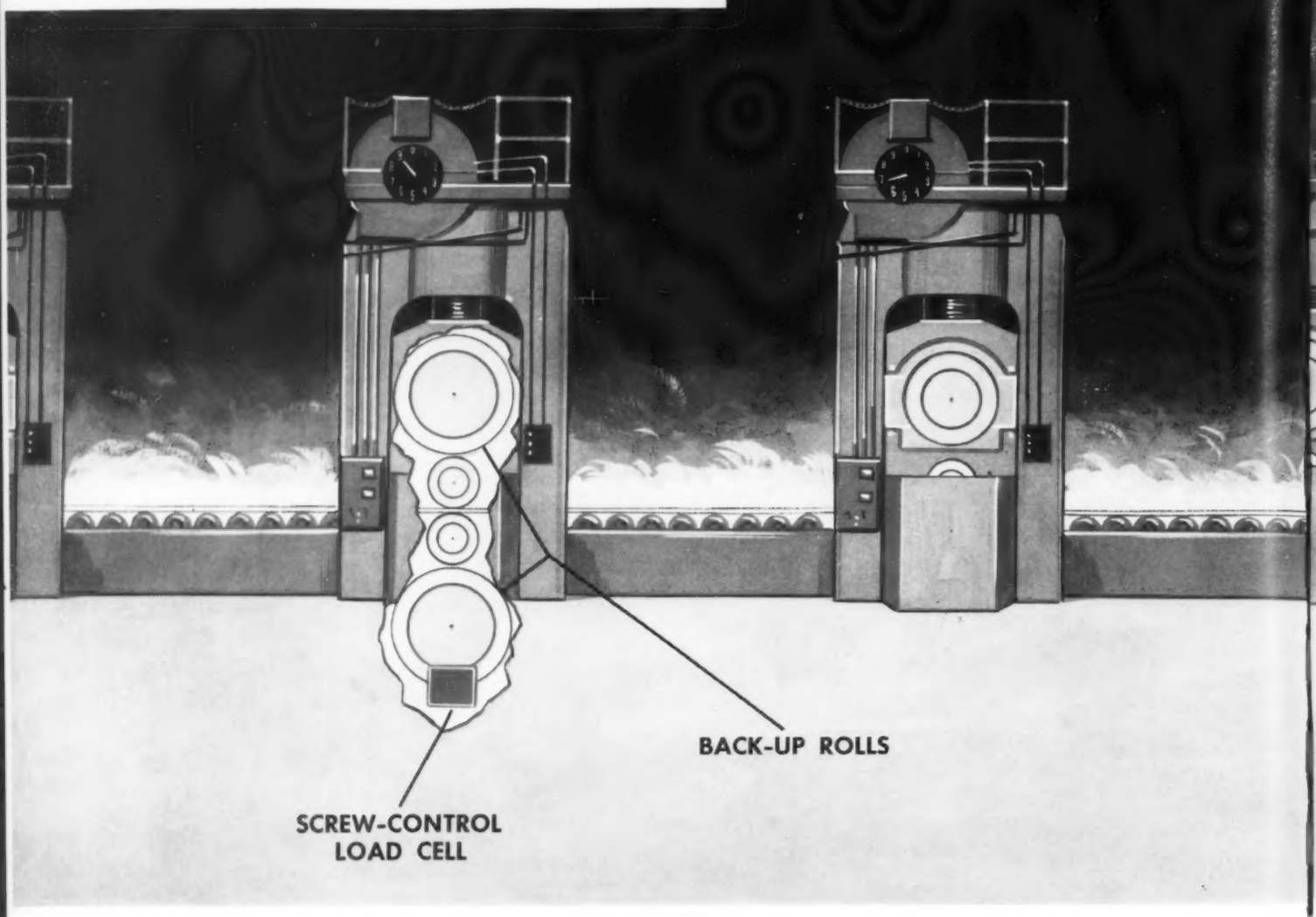


AT USS GENEVA WORKS

G-E automatic gage control maintains

A new, vastly improved method of automatically controlling gage on hot-strip mills is available now. Greater strip uniformity and increased yield per ton of steel will result from use of this thickness control system, developed jointly with U. S. Steel Corporation engineers, and now installed at USS's Columbia-Geneva Steel Division, Geneva Works, Provo, Utah.

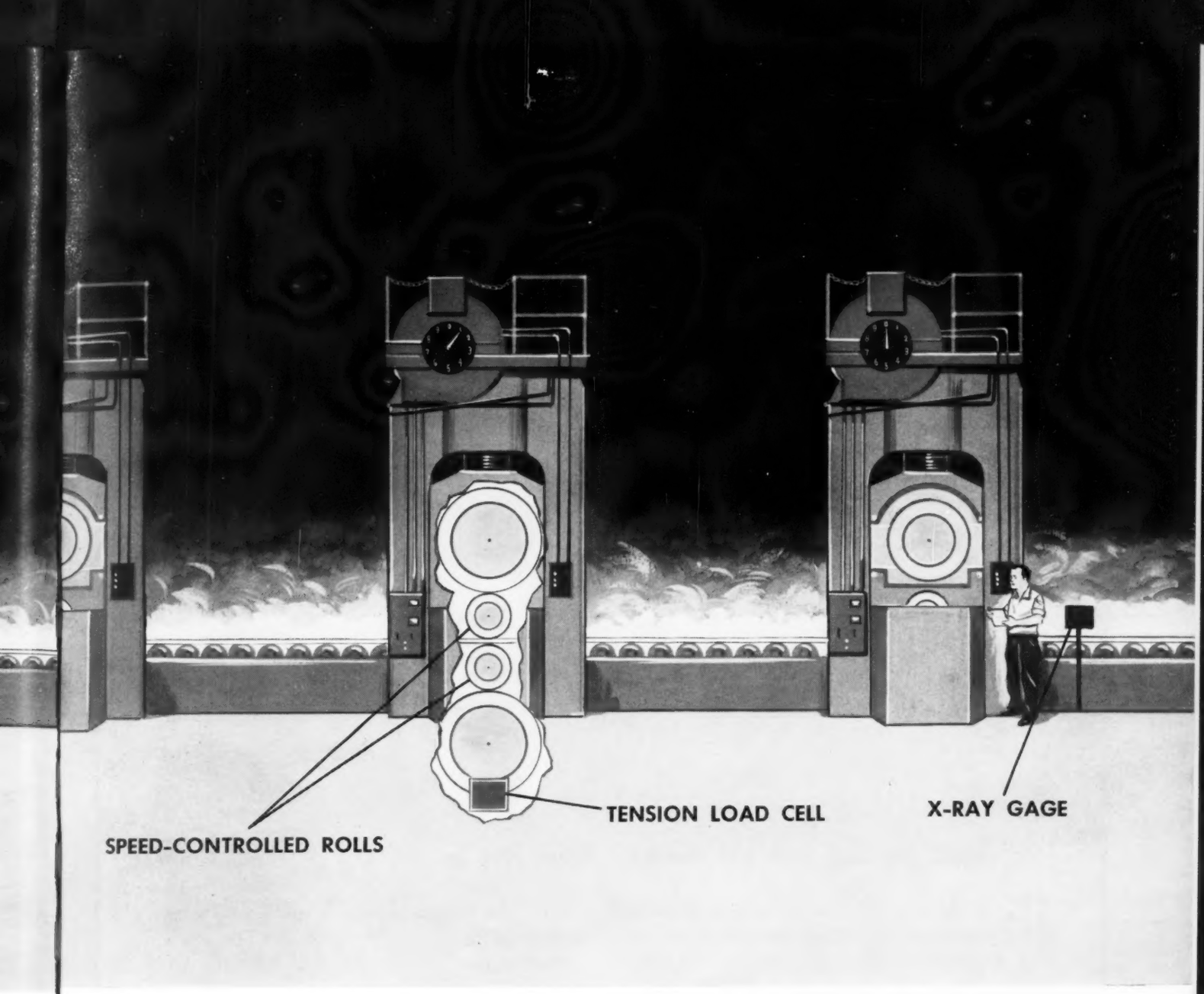
HOW UNIFORMITY AND YIELD ARE CONTROLLED

The system operates on the basis of off-gage steel automatically correcting itself by "triggering" the control to change the roll settings and inter-stand tension. As the temperature or gage of the strip being fed to the mill varies, the pressure against the rolls varies. At the second stand, this change in pressure is detected by the load cell where it is converted into power to move the screwdown motors. This entire operation is completely automatic and is initiated in a fraction of a second.

At the fifth stand, the same detection system is used to recheck the gage of the strip. However, at this point, the correction is made by adjusting the speed of the rolls, rather than their position. This controls the tension of the strip on either side of stand five, depending upon the correction required.

Automatic correction for hot and cold spots—As hot and cold spots pass through the mill, the control "feels" the difference in the hardness of the strip and automatically adjusts inter-stand tension to maintain a constant gage.

Strip "tail" is rolled to gage—The "tail" of the strip is often off-gage as a result of loss of tension as the end of the strip passes through the mill. The gage control



strip uniformity—increases yield

system adjusts the rolls or inter-stand tension to compensate for this loss of tension and rolls the "tail" to closer tolerance thickness, resulting in less scrap and greater yield.

Automatic correction for long-time drift—An x-ray thickness gage is normally used in conjunction with the control. The x-ray continuously measures the gage of the strip, and automatically makes corrections to compensate for thermal effects and mill drift.

For complete details on this new gage control method, contact your G-E Apparatus Sales Engineer today, or write to Section 785–8, General Electric Company, Schenectady, N. Y., for bulletin GEA-6947. Industry Control Department, Roanoke, Virginia.

Progress Is Our Most Important Product

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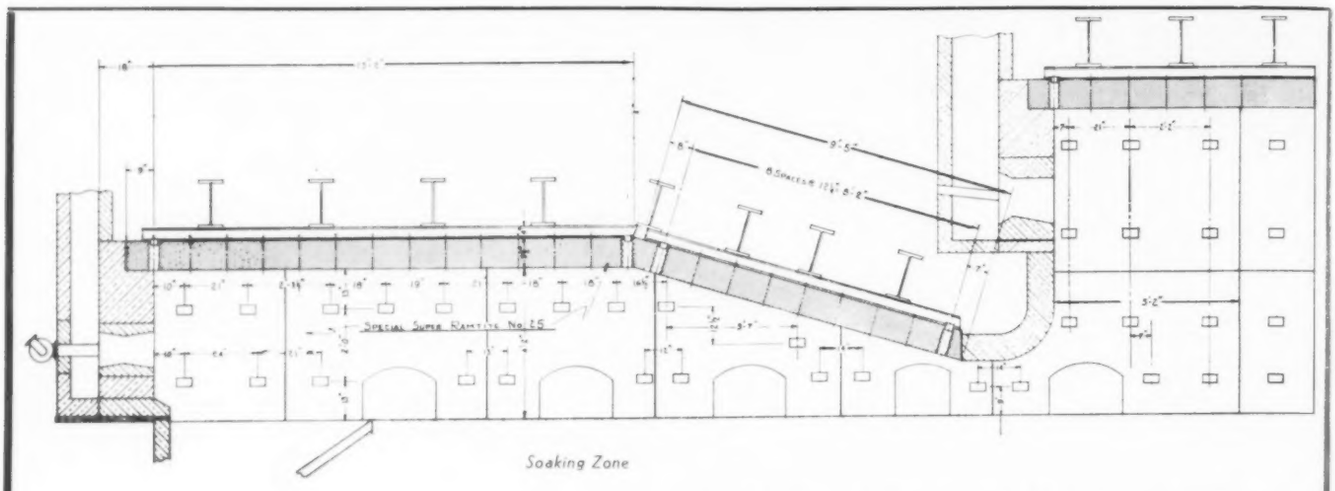
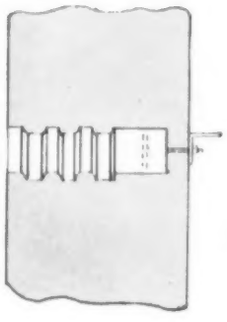


Partial View of Slab Heating Furnace at COLUMBIA-GENEVA STEEL CORPORATION, GENEVA, UTAH, showing soaking zone and part of heating zone. In the maintenance program of this existing furnace, RAMTITE* was used in the roof and side walls. **T.M. Reg. U. S. Pat. Off.*

RAMTITE INSTALLATION



Typical Wall Section, showing the A52X Anchor, set in Special Super RAMTITE No. 25. This was the basic type of anchor used throughout the job.

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IF YOU START with a furnace properly designed to incorporate economy as well as efficiency, its maintenance is usually economical also!

The Geneva Case parallels others of like nature. In this Slab Heat Furnace, with suspended wall and arch construction, the type of maintenance was designed with economy in mind. Its unique feature is its method of anchorage. ONLY A SINGLE TYPE ANCHORAGE WAS USED! This saved money in buying and the intricate installing of dozens of shapes. It also saved (and saves) inventory of so many refractories and the necessary storage space required.

When the furnace was shut down for maintenance recently, the Special Super RAMTITE No. 25, was rammed in, and later 90-RAM Hi-Alumina Plastic, with its distinctive characteristics, was installed in the hearth of this furnace.

A complete sales engineering service is available to your Engineering, Mason and Ceramic Departments to study your refractory problems and make suggestions for your specific needs.

Contact your local or nearby RAMTITE representative or write us today for information. The handy coupon below will bring bulletins of particular interest.

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No. 240

Farval automatic systems lubricate Geneva Works 45-inch slabbing mill

The fast and synchronized action of this 45-inch slabbing mill at the Geneva Works of Columbia-Geneva Steel Division, U. S. Steel Corporation depends to a large extent on properly lubricated bearings. Sixteen Farval systems automatically lubricate more than 1,000 bearings throughout the slabbing mill. Other Farval systems serve more than 6,000 bearings at the Geneva Works. Lubricant in the correct amount is delivered at regular intervals under the most rugged conditions and combinations of heat, shock and vibration.

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32 Clevelands keep 450-ton ladle cranes on the job at Geneva Works

Moving big tonnage up and down, forward, backward and sideways is all in a day's work for 32 Cleveland built-in drives installed on the bridge and hoist of these 450-ton ladle cranes. These and many other Cleveland Worm Gear Drives and Speed Reducers can be found throughout the mill driving pushers; levelers, edgers, conveyors and other cranes.

Because of their established "long-life" service records, Cleveland drives are recognized leaders for keeping maintenance and replacement costs to the absolute minimum. Contact a Cleveland Field Engineer, or write for Bulletin 145 describing how Cleveland Worm Gear Drives solve tough production problems and reduce maintenance costs.

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CLEVELAND
Worm Gear
Drives

Symposium on Sinter Plants

Late sinter plants reflect a vast amount of engineering and development thinking given to sintering.

"J & L'S CLEVELAND WORKS SINTER PLANT"

by K. S. Loofboro,
Superintendent Blast Furnaces, Coke Ovens and Docks,
Jones & Laughlin Steel Corp.,
Cleveland, Ohio

THE new sinter plant of the Jones & Laughlin Steel Corp. at Cleveland, Ohio, started operating in November, 1957, and produced some 120,000 tons of sinter before shutdown during the business lull. Operations were resumed the first week of July, 1958. During the initial period of operation, the various units were broken in, and necessary changes and adjustments were made. Much was learned from the operation, but further experience will be necessary for a complete evaluation of plant efficiency and product quality.

This paper describes the physical layout of the plant, and summarizes the experience to date. In general, the plant contains the products of three major designers and suppliers.

STRAND AND ACCESSORY EQUIPMENT

Strand—The strand is 8 ft wide, 128 ft long and has 16 windboxes. The active windbox area is 1024 sq ft. The machine contains 95 pallets, each 42 in. wide and 16 in. deep, and is equipped with straight mechanical seal bars. The machine speed range is 26 to 158 in. per min.

Figure 1 shows a portion of the strand at the ignition end.

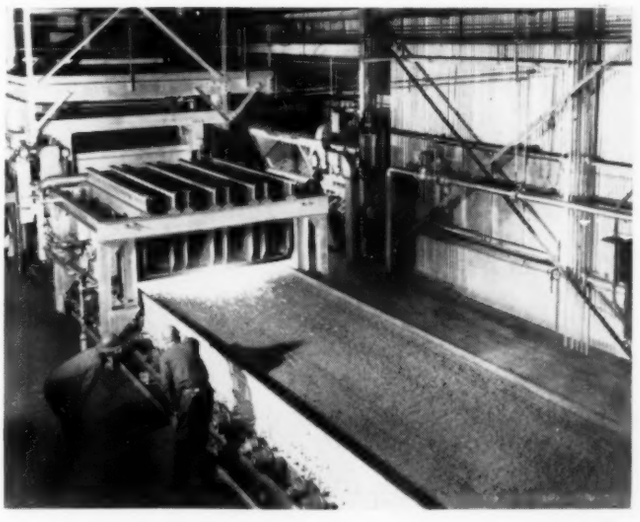
Sintering fan—The sintering fan has a design rating of 280,000 cfm at 300 F and 30-in. water column. This is equivalent to 273 cfm per sq ft of active hearth area.

Power to drive the fan is supplied by a 2000-hp synchronous 900-rpm motor through a fluid coupling. The maximum fan speed is 870 rpm.

Figure 2 shows the fan in relation to the duct work and dust collectors.

Dust collectors—Dust collection is obtained by means

Figure 1 — The strand is 8 x 128 ft, has 16 windboxes, and contains 95 pallets.



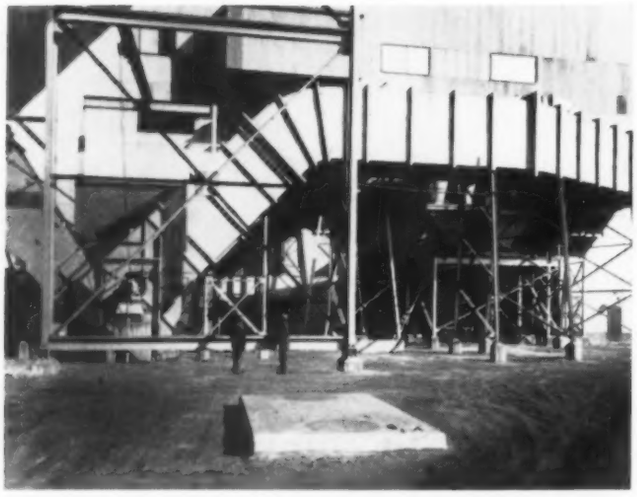


Figure 2 — Shown is the 280,000-cfm sintering fan and its duct work and dust collector.

of a large drop out chamber at the feed end of the strand, and 16 dust collectors arranged in two banks; each bank having eight collectors in parallel. Provision has been made to install an electrostatic precipitator in the future, if necessary. Collection of the dust from the cyclones is through a sealed conveyor system to a return belt. This same return belt also collects the larger particles from the various drop out boxes along the strand, and returns the entire load to the hot returns circuit.

Hearth layer—Sinter which has been screened between $\frac{7}{8}$ and $\frac{3}{16}$ in. is utilized as a hearth layer. It is fed onto the pallets prior to the mix addition by means of a roll feeder.

Mix addition—The prepared mix is fed to the strand by means of a roll feeder. By means of probes which contact the mix on the pallets, the machine speed is automatically controlled according to the rate at which the operator supplies prime raw materials from the bins.

The bed depth is controlled by a cutoff bar with gravity type flat links for smoothing the bed surface. In operation we attempt to control the feed rate and machine speed so the cutoff bar is not necessarily used.

Ignition furnace—The ignition furnace is a gas-fired brick arch type with two burners on each side and four burners on one end. It burns coke oven or natural gas, and the controls are manual. A built-in safety valve shuts the furnace down in the event of any interruption of the gas or air supply.

Figure 3 — Mix is being prepared by the table feeders.

Sinter breaker—The sinter breaker is the pronged roll type with water-cooled bearings and drive shaft. It is driven by a 40-hp motor through a speed reducer. Speed of the breaker is four rpm. The breaker has 14 blades, with four teeth on each blade. The breaker spacing is 6 in.

Hot screen—The crushed sinter drops onto an oscillating screen conveyor, 60 in. wide, 10 in. deep and 25 ft long. The design capacity of this screen is 225 tons per hr. The bed of the conveyor consists of ten removable sections $2\frac{1}{2}$ ft long. Five of the sections have $\frac{7}{8}$ in. diam T-1 alloy steel bars with $\frac{5}{16}$-in. openings. The hot undersize sinter drops into a hot fines bin for return to the sinter plant feed circuit.

The screen is driven by a 25-hp motor, and the top frame trunnions are water cooled.

The oversize sinter, or product, discharges to a distributor which charges the sinter cooler.

RAW MATERIALS HANDLING AND STORAGE

Incoming prime raw materials are received from an ore transfer car from the ore yard. Secondary raw materials such as coke breeze, flue dust, scale, etc., are received in railroad cars. All raw materials are transported by conveyor belts to a screening station where they can be separated on $\frac{3}{8}$-in. screens or diverted directly to one of the eight storage bins or silos. Plus $\frac{3}{8}$-in. raw materials are diverted by conveyor belts back to the ore yard for direct use in the blast furnaces.

The raw materials are stored in bins as follows: (1) prime raw materials—any one of four bins of 700-ton capacity each, (2) flue dust-one bin of 440-ton capacity; (3) sinter fines-one bin of 410-ton capacity; (4) coke breeze-two bins of 145-ton capacity each. All bins are equipped with $8\frac{1}{2}$ ft diam table feeders.

Figure 3 is a view of the mix being prepared by the table feeders.

SINTER COOLING

The cooler is of circular design. Coolers of this type were first used at the Appleby-Frodingham Steel Co. in England. In this cooler the moving structure consists of a number of trays each attached at the front to an inner and outer circular channel and supported at the rear end by two wheels running on curved rails. At the discharge point of the cooler there is a downwardly inclined portion of the rails, and the rear of each tray successively lowers at this point until the tray is nearly vertical and the sinter slides off. The rear of each tray is then raised by an upward sloping section of the rails and returned to the horizontal position for loading.

The actual cooling takes place under a hood which covers somewhat over three-fourths of the total circle formed by the cooler. This hood is maintained under reduced pressure by three axial-flow, induced-draft fans each having a capacity of about 150,000 cfm at an average temperature of about 300 F. The hood is sealed to the trays at the sides by flap type seals which

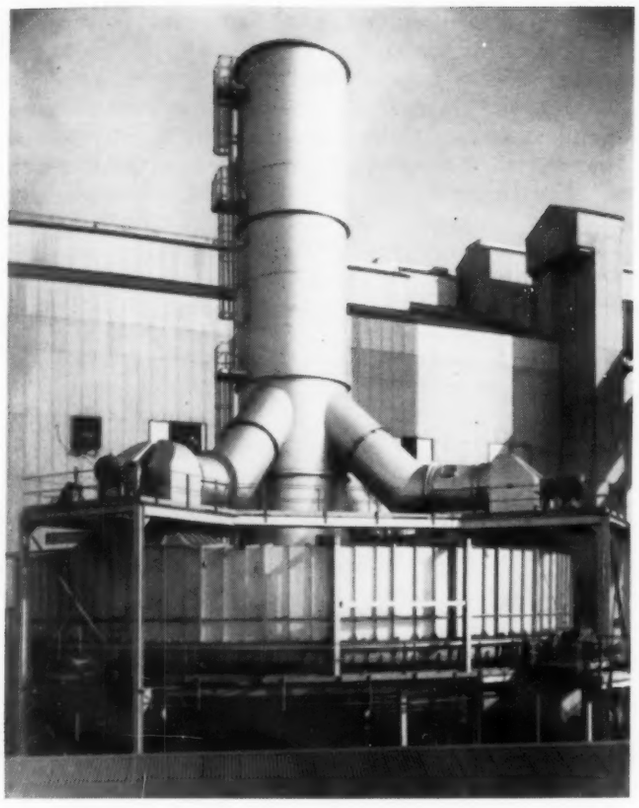


Figure 4 — The cooler is of circular design.

are held against a flange on each side of the tray by the pressure differential and at each end by three rows of air locks, each consisting of a number of pivoted sections which ride on the sinter.

The trays themselves are 7 ft in width, and the mean diameter of the circle which they form is 65 ft. The cooling area is somewhat less than 1200 sq ft. The cooling air is drawn up through the bottoms of the trays, which are exposed to the outside atmosphere and which are equipped with a patented screen and louvre arrangement to facilitate upward air flow while at the same time minimizing sinter drop through.

The entire rotating part of the cooler is driven at a single point by a friction drive operating on a flange attached to the outer circular channel. About 10 to 15 hp is required for the drive and this is supplied by a d-c motor. The fans are each equipped with 150-hp constant speed motors.

The cooling time can be varied from about 15 to about 45 minutes by varying the speed of the d-c drive motor. This variable speed is necessary because it is desirable to keep the trays fairly well filled regardless of the production rate at which the machine is being operated. The normal cooling time is about 20 minutes at full production, the maximum rated capacity is 3500 tons per day.

Figure 4 shows the cooler.

MIX PREPARATION

The mix components are pugged in one of two 26-in. pug mills of 200 tons per hr capacity each. One mill is a standby.

Also available for mixing and/or pelletizing is an 18-ft "flying saucer" or disk, equipped to tilt between 50 and 62 degrees, and supplied with an adjustable 4-ft lip or brim, and an adjustable a-c drive. The disk is driven by a 75-hp, 1800-rpm motor.

Any combination of pug mills and/or disk can be used in preparing the mix.

The disk is considered as a production size unit for plant experimental studies in the future.

THICKENER AND FILTER

The flue dust sludge system consists of a 90-ft, diameter by 16 ft side depth thickener and one disk type vacuum filter with five disks of 8 ft 6-in. diameter.

The rated capacity of these units is 185 tons of blast furnace flue dust per 24 hours.

Filter cake is added to the mix at the entry point of the hot returns to the circuit. A reversible feed belt makes it possible to stock the filter cake outside the building, if desired.

INSTRUMENTS AND CONTROLS

Figure 5 shows the main control panel. It is enclosed in a pressurized room supplied with filtered air. All instruments and controls, except those of two belt meters for incoming raw materials and those of the thickener and filter are located in this room.

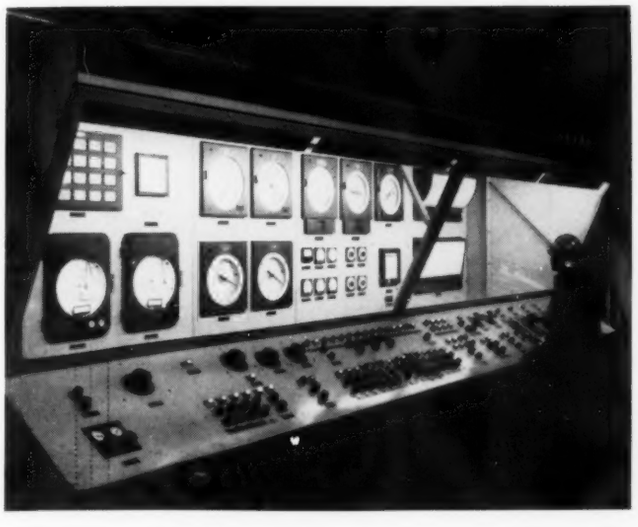
Ten of the 16 windboxes of the strand, as well as the main sinter fan, have vacuum indicators here, and the same ten windboxes show waste gas temperatures and make a continuous record on strip chart recorders.

The machine speed in inches per minute is recorded on a strip chart, and a pallet counter gives a total of the number of pallets produced.

The speed of the main sintering fan can be controlled from the operating panel board, and instruments inside the control room tell the operator the fan speed, power being used and the position of the scoop in the hydraulic coupling in the fan room. The fan can be stopped from the operating panel, but for safety reasons, it must be started in the fan room.

Twelve belt meters continuously weigh the various mix components, the total weight of the mix, the weight of the incoming raw materials to the plant, and the

Figure 5 — All instruments and controls, except those of two belt meters for incoming raw materials and those of the thickener and filter, are located in the main control room.



weight of the product. Each instrument tells the operator the rate in tons per hour, and makes a record of the rate on a circular chart. The instrument also integrates the total tons and makes it possible to tell the total material handled and the amount of sinter made over any desired period of time.

Four of the bins or silos metering raw materials to the mix are equipped with automatic controls. The operator determines the per cent of additive materials (usually fuel, cold fines and flue dust) he desires, and sets the control knob accordingly. As the amount of hot returns, dust and filter cake fluctuate, the amount of these additives is automatically varied to give a constant per cent of the total mix. Likewise, any increase or decrease in the amount of prime raw materials to the machine by the operator, is automatically compensated for by the additive feeders.

Once the operator has the machine running on a balanced mix, the production rate can be increased or decreased (depending on burn-through conditions at the discharge end) by simply increasing or decreasing the amount of prime raw materials metered to the mix. Everything else is automatic.

The instrument room also contains gas and water recording meters, an annunciator and a PA (public address) control system. The PA system has 14 outlets throughout the plant, and permits the operator to practically run the plant from this location. The annunciator warns when some piece of equipment has stopped, and an electrical interlock system shuts down all equipment which is connected in any way with the trouble.

MAJOR EXPERIENCES TO DATE

Pallets—We have been plagued with cracked frames on many of the pallets. This in turn has caused binding of the strand and the shearing of drive pins. The cause and remedy has not been completely isolated.

Grate bars—The original grate bars were in two sections, with ample clearance at the clamp-on-lugs for movement for self cleaning. These bars did not prove satisfactory and are being replaced with single section bars.

Hot screen—The hot screen has operated without trouble of any kind. However, we are adding two more screening panels to improve screening efficiency.

Sinter fan—The sintering fan must be run at reduced speed until the waste gas temperature is above the dew point. Otherwise a build-up can occur on the fan blade, resulting in an undesirable fan vibration.

Cooler—This cooler is located on steel framework some 20 ft above the ground level. It was found necessary to strengthen the structural work and pour concrete pads around the bases of the three fans to eliminate vibrations. The unit has done a very good job of cooling.

Disk—Thus far the disk has only been used as a supplementary mixer with the pug mills. We eventually expect to eliminate the pug mills entirely.

Future work with the disk will include attempts at partial pelletization of the mix for better bed permeability. In this connection, previous experience indicates the advantages of using a closed circuit with pelletizing equipment.

One of the limiting factors in achieving marked pelletization of the mix, is the character of the prime raw materials we must agglomerate.

Belt meters—The belt meters have proved very helpful in maintaining a balanced mix to the strand. However, they are not yet completely satisfactory in accuracy, for weighing incoming raw materials and product.

The load cells can be damaged by overweights on the belts and inattentive personnel. The area of all load cells should be enclosed, and dust accumulations should be removed regularly.

Screening and circulating load—The hot sinter, as previously mentioned, will have additional panels added to improve the screening efficiency of the hot returns. It may also be desirable to increase the breaker openings above 6 in. to minimize breakup.

The secondary sinter screen (which screens cooled sinter to provide a hearth layer and remove additional fines) consists of a double deck screen. The upper deck is of $\frac{3}{4}$-in. steel plates with $\frac{7}{8}$-in. slotted openings. The bottom deck is made of rods with $\frac{3}{16}$-in. openings. We obtained a life of about 70,000 tons of sinter on the bottom deck, and about 80,000 tons on the top deck.

The circulating load in this plant is too high. Possible changes to the breaker, hot screen, and smaller openings in the bottom deck of the secondary screen should result in a better balance.

Belt transfer points—The belt transfer points in this plant have not been trouble free. With incoming raw materials especially, pile-ups are regularly encountered.

Hearth layer —With good grate bars and the type of raw materials we currently sinter, a hearth layer is not always necessary. It is, however, a good feature to have in the plant for use as required.

It is felt that a broader range of sized sinter can be used as a hearth layer. When a better balance of the circulating load is obtained, it may be possible also to use the normal undersize of the secondary sinter screen as a hearth layer, thus simplifying the operation and releasing a silo for other raw materials.

SUMMARY

Despite the operating annoyances listed above, we feel the Cleveland Works sinter plant is a well planned plant of modern design. It has exceeded its specified operating rate of 2500 tons per day, and when the return circuit system is better balanced, the yield of sinter per pallet will increase. The plant has averaged a downward burning rate of 0.83 in. per min, but the pallet yield has only been 0.91 ton per pallet. The nominal volume capacity of the pallets with our 15-in. bed depth is 35 cu ft each.

This plant has no facilities for grinding coke, but a rod mill is planned. Current size specifications of the coke are $-\frac{3}{16}$ in., but even with this specification, an appreciable amount of tramp oversize material found its way into the product and raised hob with the sintering practice. A $\frac{3}{16}$-in. screen was recently installed in the top deck of one of the ore screens, and all of the coke breeze is now rescreened before using. This has improved the sintering practice tremendously. However, like most operators, we would prefer all coke breeze to be $-\frac{1}{8}$ in. for best sintering practice.

Figure 1 — No. 2 sintering plant at Weirton Steel Co., had to be designed within severe space limitations.

"WEIRTON NO. 2 SINTER PLANT"

by George W. Watson,
Superintendent, Sinter Plants,
Weirton Steel Co.,
Div. of National Steel Corp.,
Weirton, W. Va.

THE Weirton Steel Co. Div. of National Steel Corp. began operating the No. 1, 8 x 104-ft, sinter machine in October, 1955. In order to realize the full potential of the existing blast furnace plant through 100 per cent beneficiation of the furnace burden, additional sintering facilities were planned. This paper reports primarily on the equipment and design of the No. 2 sintering plant. Physical space limitation very strongly influenced this design. Figure 1 is a general view of the plant.

ORE HANDLING

A system of 48-in. wide belts, Figure 2, with a capacity of 1200 tons per hr travels the length of the ore yards inboard of the pier legs of the ore bridges. Loading hoppers fixed to the pier legs feed the belts by 72-in. pan feeders with a top capacity of 800 tons from each of the three bridges equipped for loading belts. Discharge from the belts is into a 550-ton bin at the sinter plant. Another 550-ton bin is located on the highline for use as an emergency source of ore by transfer car.

Both ore bins feed, with vibrating feeders, a common belt system which leads to primary separation and crushing. Primary separation is done on a wobbler, essentially a series of elliptical rolls which maintain a constant opening through which the −2-in. x 0-in. material falls while the ellipses furnish forward motion to the +2 x −8-in. ore feeding it to a cone crusher set to crush to 2 in. Crushed ore is discharged to the belt that had previously received the −2-in. ore. The total load is conveyed through several transfer points to a 55-ton surge hopper above three 6 x 12-ft rod deck screens. Separation through $\frac{3}{8}$-in. screens has been used with the $-\frac{3}{8}$-in. ore going to the sinter plant stock bins over a series of shuttle conveyers; −2, $+\frac{3}{8}$-in. ore going to storage bins above the highline bin track for withdrawal by transfer car and

Figure 2 — This system of 48-in. wide belts, with a capacity of 1200 tons per hr, feeds a 550-ton bin at the sinter plant.

directly discharged to the highline stock bins. There is also an emergency discharge directly to the ore yards for this material should the storage bins be temporarily full.

MISCELLANEOUS MATERIALS HANDLING

Miscellaneous material arrives at the sinter plant in hopper cars and is unloaded into one of two track hoppers. One track hopper, used entirely to unload crushed limestone, is located on the highline lead track; the other, or main miscellaneous track hopper, is located at the south end of the plant and is serviced by a special spur track. Both track hoppers are equipped with a car haul, car shakeout, 4-car thaw area, and an 85-ton capacity double cone bin. Each cone on the limestone hopper feeds a 60-cu ft skip bucket which dumps into a 400-ton concrete silo. The silo has a steel 70-degree cone wrapped with steam coils for all-weather operation. A vibrating feeder under the silo feeds two short belts that join the limestone system with the main miscellaneous materials system. At the junction point of these two systems, transfer from one to the other will normally be done by chute arrangement although an impacter is located here for use during extremely cold weather to break frozen lumps of limestone fines.

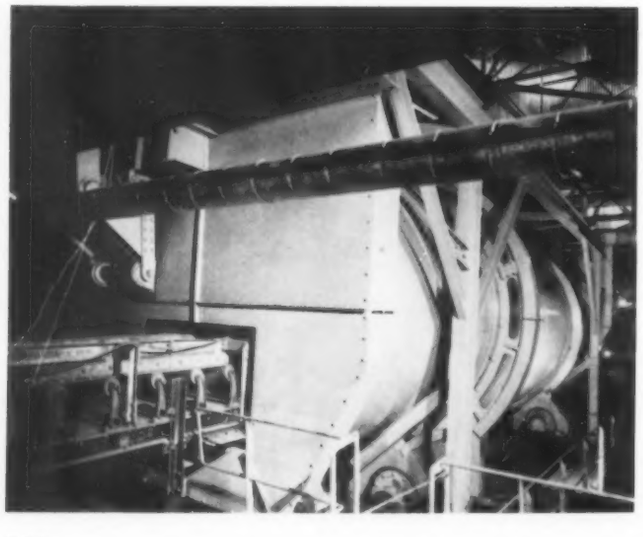
Two track bins are located at the main unloading point. One feeds a double shaft pug mill used for pugging of hot flue dust; the other bin feeds all other material with a vibrating pan feeder onto No. 4 belt. No. 4 belt is a 30-in. wide, 250-fpm belt at the bottom of the main track hopper and carries all miscellaneous materials to the 6 x 12-ft scalping screen. This screen is covered with a 1-in. square mesh cloth and is used to prevent plugging and damage from tramp material. Underflow from the screen is to a shuttle conveyer system which places the material in the storage bins.

RAW MIX CIRCUIT

There are 14 bins of 620-ton capacity, based on a cubic foot weight of $-\frac{3}{8}$-in. ore. Each bin feeds from an 8 ft-6 in. diam individually-driven, brick-faced table feeder. Control of feed is roughly established by the bin gate setting and is given a final setting by an individual d-c rheostat for each table at the main panelboard. A variable voltage generator supplying power to the table feeders can be regulated by the sinter machine operator to raise or lower the voltage to all feeders to increase or decrease the feed in established ratio. The feed belt receives all material, mix from the tables, dust from the cyclones, hot fines from the hot sinter screens, and filter cake, and passes across a belt scale which registers total raw mix to the machine.

Raw mix is pugged in an 11-ft diam x 14 ft-6 in. long drum pug mill to give a smooth, intimate mixture. Secondary mixing is done in a 12-ft diam x 40-ft long balling drum, Figure 3. Water is available at either primary or secondary mixer and is controlled by the sinter machine operator at the main panel board through an electrically-actuated hydraulic valve with selsyn indicators on the panel board.

Figure 3 — Secondary mixing is done in this 12-ft diam x 40-ft long balling drum.



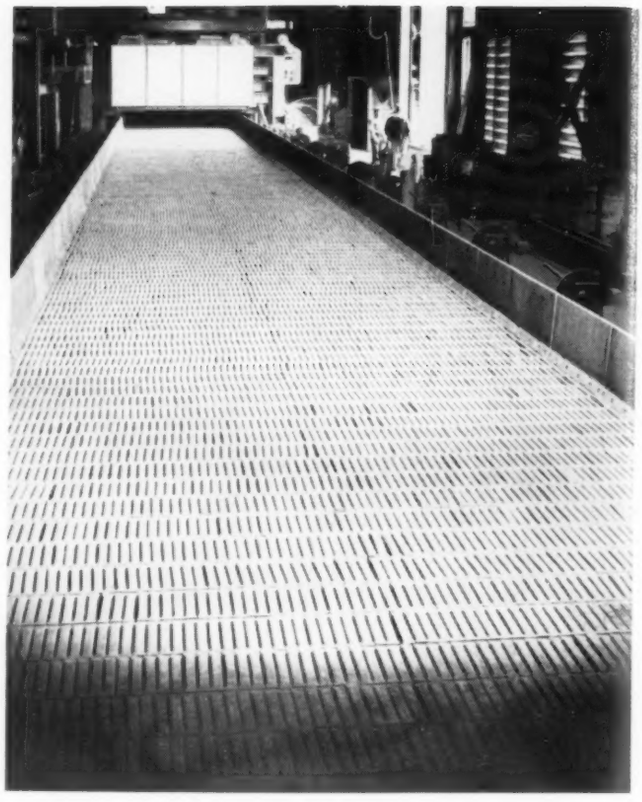


Figure 4 — The sinter machine is 12 ft wide x 147 ft long.

MACHINE FEED ARRANGEMENT

At the feed end of the sinter machine a gravity fed 55-ton hopper with a pneumatically-operated feed gate places a 1-in. hearth layer of $-\frac{1}{2}$, $+\frac{3}{16}$-in. screened sinter on the grates. A reversing shuttle conveyer fills a small surge hopper over a 4-ft diam x 12-ft long rubber lagged roll feeder for placing raw mix on the machine.

IGNITION FURNACE

Ignition furnace is of the radiant arch type, 11 ft long, giving a 45 to 90-sec ignition time, depending on machine speed. Firing is done through four nozzle mixing burners on each side wall and two auxiliary rear burners. The two rear burners fire directly on the

bed surface at the sideboards to improve the ignition at what is usually the hardest section of the bed to ignite. Gas is 550-Btu coke oven gas regulated to 11-in. water column pressure and metered across a 50,000-cfhr orifice. The furnace is constructed to restrict as closely as possible all air except combustion air, introduced into the gas stream at the nozzles, so that sinter temperature can be approached on the top one in. of bed before the carbon in the mix is completely burned.

SINTER MACHINE

The sinter machine is 12 ft wide x 147 ft long giving an active grate area of 1764 sq ft, Figure 4. Pallets are cast steel with a 5-rib frame, 18-in. cast iron side boards, and 42 in. long. Grate bars are finger type, cast malleable iron with four rows of small, 10½-in. bars covering the width of the pallet. The 14 windboxes are split on the centerline of the machine with downcomers going down both sides to separate collector mains. Each downcomer is equipped with a butterfly valve. These butterflies are machined to clear the sidewalls of the downcomers by 5/8 in. to insure that they remain free operating and yet block the passage sufficiently to allow the main fan louvers to be opened without seriously overloading the fan motors. The valve handles have been extended through the burning floor and are operated from that floor. On cold startups with an empty machine, one man on each side of the machine can open these valves as the material covers each windbox thus eliminating covering the machine with paper which, on a 12-ft wide machine, could be a slow and laborious process.

Each collector main passes the hot dirty gases through four parallel cyclone type dust collectors into the fans. The fan on each of the collector mains is rated at 255,000 cfm, 35-in. suction, 350 F, at 712 rpm, and the fans are driven by 2500-hp synchronous motors. Total air on the machine is 510,000 cfm or 123,000 cu ft of air per ton of sinter, based on a 6000-ton per day rate of production.

SINTER BREAKER

The sinter breaker, Figure 6, is a spike roll type, 6 ft-2 in. diam from tip to tip, weighing 28 tons, and having a speed range of 10 to 28 rpm. Teeth are set on 15-in. centers and drive through bars set with a 12-in. clear spacing. The shaft is a hexagonal forging drilled through the center for water cooling. Tips and all other high wear points have been completely covered with hard surface welding.

HOT SCREENS

Parallel hot sinter screens have been installed between the sinter breaker and the cooler. Each screen is 5 x 20 ft and is covered with ten rows of 2-ft long sections of cast manganese bars. Spacing can be changed from 3/16 in. to any desired opening by placing washers, as spacers, between the bars. Sinter from the top of the screen flows onto the cooler; the fines go into a surge hopper and are immediately conveyed back to the main raw mix feed belt where they are placed in a small plowed trough on top of the raw mix. These

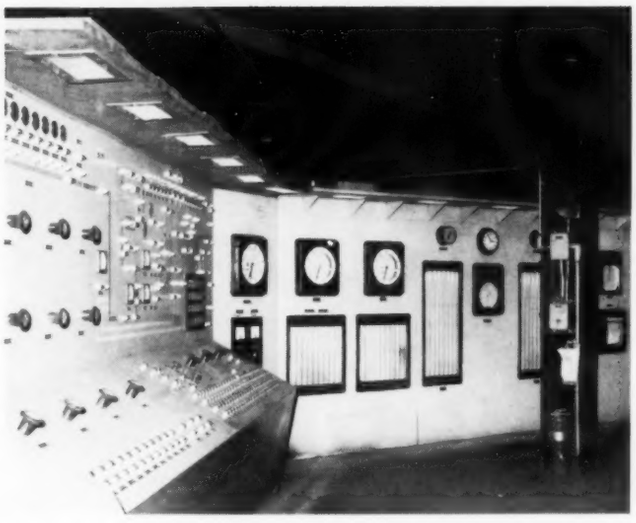


Figure 5 — Main control panel and instruments of the sinter machine.

screens are mounted on motor-operated carriages so that they may be moved to an open position for maintenance.

SINTER COOLER

The sinter cooler Figure 7, is a forced-draft, straight-line type cooler 10 ft wide x 150 ft long, giving an effective grate area of 1500 sq ft. The two fans each are capable of 252,000 cfm, 6-in. static pressure, at 70 F. This is equal to 121,000 cu ft of air per ton based on a 6000-ton per day rate of production. The air enters a plenum chamber and is distributed evenly to each windbox. The machine itself is similar to a sinter

Figure 6 — The sinter breaker, of the spike roll type, is 6 ft-2 in, from tip to tip.

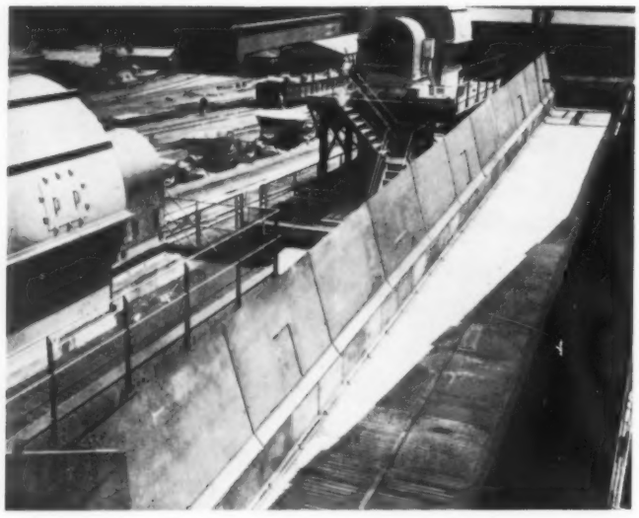


Figure 7 — The sinter cooler has an effective grate area of 1200 sq ft.

machine being composed of a pallet train driven from tail sprockets, the major differences being in the mounting of machine which is 10 degrees from the horizontal, the bed is made of formed "Z" bars rather than cast grates, and the air system is forced-draft rather than suction. Sprockets at the discharge end of the machine are geared to a drag generator to prevent opening of the pallets under load with the resultant spillage. The opening is on the return strand of the machine immediately after the release of the pallet from the head sprocket. Return from this point is by gravity.

COLD SINTER SCREENS

Discharge from the cooler is onto a series of 42-in. belts which convey the cooled sinter to the double deck 6 x 12-ft vibrating screen. Each deck is composed of 18 x 24-in. cast manganese plates. The top deck plates have $\frac{1}{2}$-in. slotted openings, and the bottom deck plates have $\frac{3}{16}$-in. slotted openings. Material from the top deck of the screen is product sinter; material from between the decks goes into a movable box which can be adjusted to split the material between the hearth layer chute and a chute to return the excess to the product belt. The underflow from the screen goes to the cold returns bin and is recirculated in the feed to the machine. There are two of these screens at this point mounted on a motorized carriage. While one is in the operating position the other screen is in an open position and available to the maintenance crews.

COKE GRINDING

The $\frac{3}{4}$ x 0-in. coke breeze from the coke plant and blast furnace screening stations is delivered to the miscellaneous materials hopper in cars and unloaded into No. 13 or No. 14 stock bin. Vibrating feeders at the bottom of these bins feed a 30-in. belt leading to the 10 x 12-ft rod mill. The mill is rated at 30 tons per hr at 12 per cent moisture grinding to 100 per cent $-\frac{1}{8}$ in. A 60-cu ft skip hoist receives the ground coke through the peripheral discharge of the rod mill and delivers it to a reversing belt on the bin floor from which it is put in either No. 11 or No. 12 stock bin.

DUST COLLECTION

High dust areas have been hooded and connected to wet dust separators. Two units rated at 75,000 cfm are over the hot sinter screens; two units rated at 60,000 cfm are over the discharge of the sinter machine; one unit rated at 20,000 cfm is over the cold sinter screen. The sizing of these units has been such that additional points may be picked up should it be necessary.

SUMMARY

The short time Weirton's No. 2 sintering plant had been operating prior to September, 1958, indicated that the plant design is basically good and the plant will reach the production goals set for it.

"NEW SCREENING AND SINTER PLANT FACILITIES AT INLAND STEEL CO."

by William O. Bishop
Superintendent, Plant No. 2 Blast Furnaces,
and Charles P. Frame,
Assistant Superintendent, Sintering Plants,
Inland Steel Co.,
East Chicago, Ind.

AT Inland a new screening station and sintering plant is being designed. It is now being erected and is scheduled to be in operation early in 1959.

The sinter machine is 8 ft-0 in. wide by 168 ft-0 in. long with 1344 sq ft of grate bar area and will have a nominal production rate of 4000 net tons per day. This machine is designed to sinter ore fines from the Mesabi range as well as ore which will be received in the near future from the new Caland property at Steep Rock.

Engineering features which are believed to be most suitable for production and of general interest is discussed in this paper. A perspective view of this plant is shown in Figure 1.

The site for this plant is a slag-filled area extending 500 ft into the Indiana Harbor turning basin on Lake Michigan and running 1300 ft parallel to the existing property.

To provide additional ore and limestone for the expected increase in iron production resulting from the new plant, the ore storage field, ore bridge walls and ore transfer car highline were extended approximately 430 ft. Although only one sintering machine is now being built, provisions are made in the initial layout whereby a second machine can be installed with a minimum of changes in conveyors and buildings.

All material handling facilities, which include the new screening station and conveyors, are sized to handle the necessary material for a 4000-ton per day production in a single 8-hr shift. The remaining time per day allows for a future second machine and main-

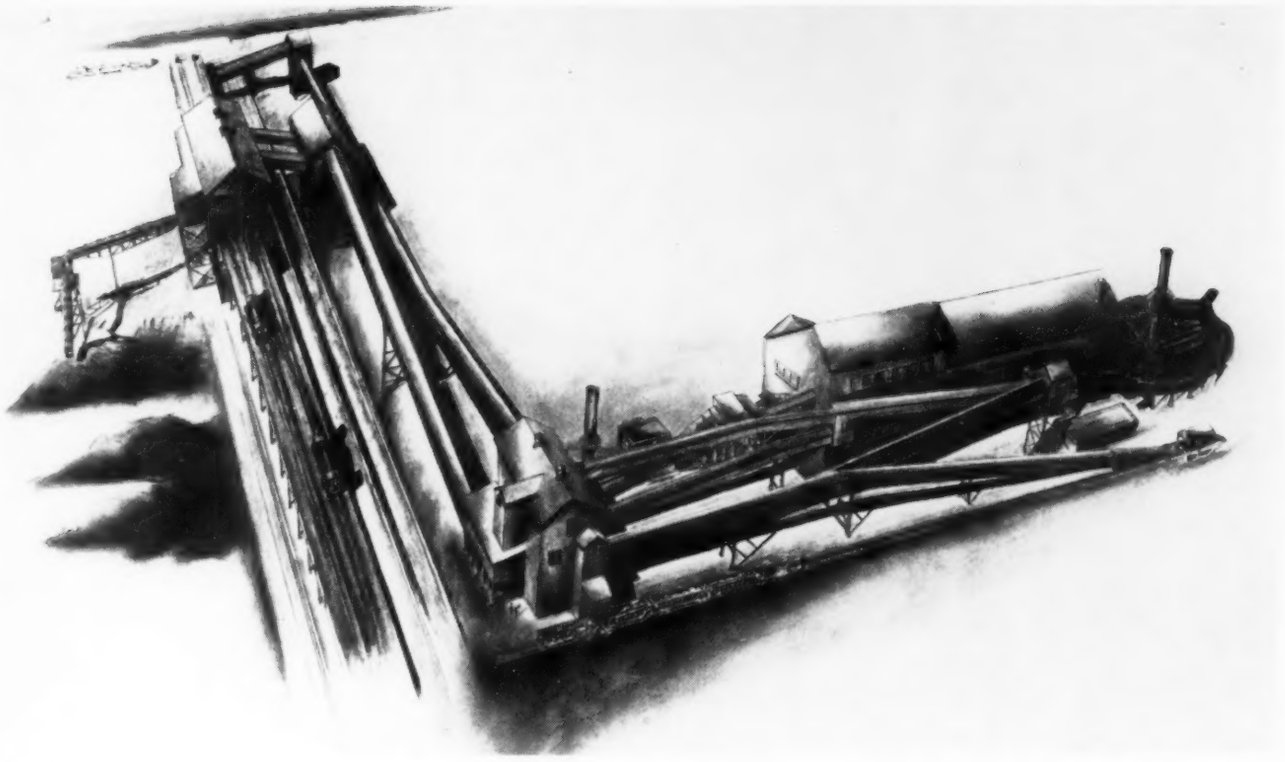


Figure 1 — New screening and sintering plant at Inland Steel Co.

tenance work. The storage bins in the main sintering building will store enough screened materials for 16 hr of plant operation.

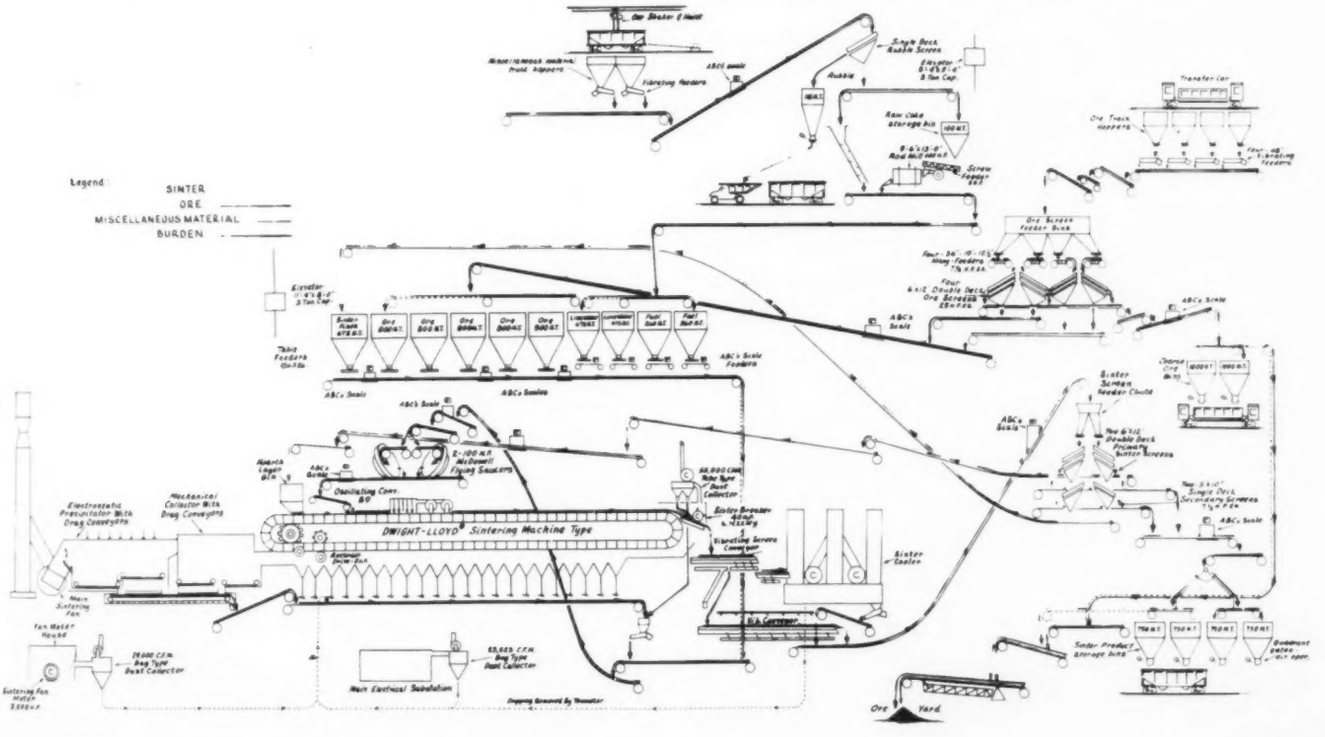
Figure 2 is a material flow diagram of this plant.

HIGHLINE LOADING OUT AND RECEIVING AREA

The ore from the storage yard is loaded by bridge into any of four 60-ton transfer cars for delivery at the north end of the highline to four track hoppers having a total capacity of 480 tons. Each of these hoppers is equipped with a 48 x 177-in. mechanical oscillating feeder rated at 600 tons per hr. In turn, the feeders convey the material to a 48-in. belt which delivers the ore to the screening station. Figure 3, a ⅛-in. scale model of the plant, illustrates this area and equipment.

There are six loading-out bins located directly over the raw material receiving bins. These bins will store the finished product from the central screening station. Four of these bins are for sinter with a total capacity

Figure 2 — This is the material flow diagram for plant No. 2 blast furnace screening and sinter system.



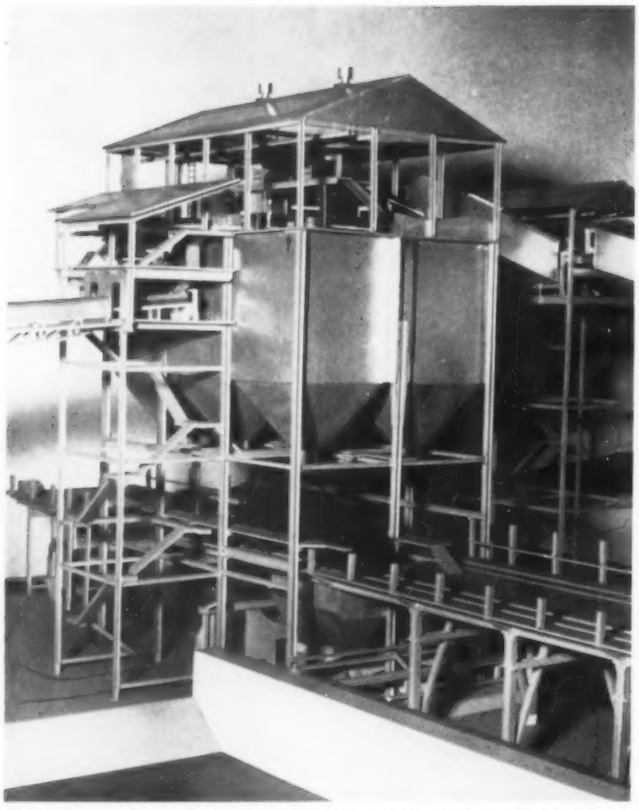
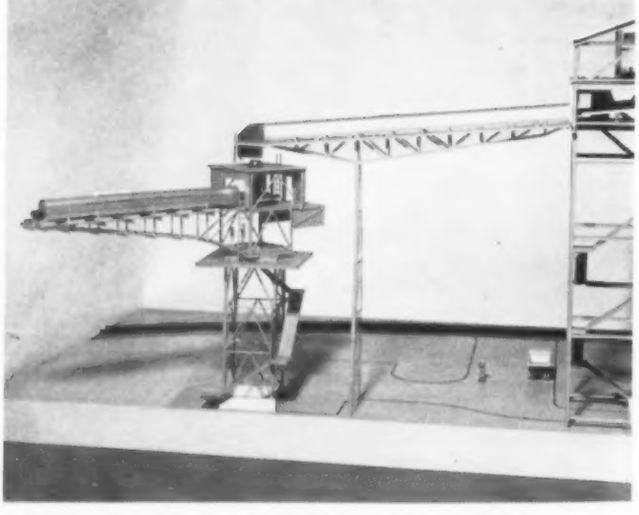


Figure 3 — This ⅛-in. scale model shows the plant equipment.

of 3000 tons; the two remaining bins are for coarse screened ore and will hold 2000 tons. On the bottom of each bin is a quick-acting, pneumatically-operated gate, controlled by the ore transfer car operator. Our safety rules stipulate that the car operator must be on the end of the car in the direction of travel at all times. After the raw material has been unloaded from the transfer car into the track hopper, the car will be spotted directly beneath one of the six loading bins. From here the operator steps onto the platform, operates the gate and fills the car. He then proceeds to the furnace with a full load of sinter or coarse screened ore. It is believed that this design will eliminate any lost time which is usually encountered between loading out raw material and receiving finished product.

Figure 4 — The stacker projects over the new ore field and can move in a 280-degree radius as shown by the model.



On the upper elevation of this same building there are three shuttle conveyors which feed the six loading-out bins. These conveyors are controlled from a single panel and can be moved ahead to convey the material to an emergency boom stacker should the bins be full. In Figure 4 the stacker model has been shown. The stacker projects out over the new ore field and has the feature of moving in a 280-degree radius. Thus, two storage piles, one of coarse ore and one of sinter, can be built up. The capacity of this 36-in. stacker belt is 600 tons per hr of coarse ore or 350 tons per hr of sinter. The total capacity of this storage area is approximately 50,000 tons.

On the roof of this building there are two power-operated vents with a capacity of 5500 cfm each to provide adequate ventilation.

SCREENING STATION

The screening station is an imposing 7-story structure rising above the ground 110 ft. As shown in Figure 5, this building completely houses the screening for the entire operation with the exception of the hot screens. The ore screens, primary sinter screens and rubble screens are all on one floor. The secondary sinter screens which separate the $-\frac{1}{8}$ in. and hearth layer from the product are on the floor beneath. With such a compact arrangement, the operating personnel can be held to a minimum.

The raw ore is delivered to four surge bins having a total capacity of approximately 100 tons. Beneath each surge bin is a 36 x 72-in. pan type conveyor which feeds onto a 6 x 12-ft double deck screen. It was felt that for convenience of operation the pan feeder should be placed directly over the screens. The floor beneath each pan feeder was omitted to allow the dribble to fall free and to facilitate maintenance.

A feature built into the surge bins is an automatic cutoff switch that will stop all belts feeding these hoppers in case of a blockage at the pan feeders.

In the throat of the hoppers a plate system was incorporated which allows the operators to direct the flow of ore to any one or all hoppers. This feature, although not necessary, was felt to be an assurance of better maintenance.

The coke crusher, a 50-ton per hr (at 12.5 per cent moisture) rod mill, is located on the main floor with a 100-ton storage bin directly above. The material coming from the miscellaneous material track hopper is conveyed to the coke storage bin. However, if the material need not be crushed, it can bypass this bin and crusher by means of a reversible conveyor which will place it on the main belt via a chute.

The sinter screens are 5 x 10-ft double deck for the primary screening and 5 x 10 ft single deck for the secondary screening. The anticipated size fractions at this time are as follows: $+\frac{3}{4}$ in. -6 in. to the product bins on the highline, $+\frac{3}{8}$ in. $-\frac{3}{4}$ in. to the hearth layer bin, and $+\frac{1}{8}$ in. $-\frac{3}{8}$ in. also directly to the product bins. The $-\frac{1}{8}$-in. material will be conveyed to the fines bin in the main building. It is understood that during normal practice, the hearth layer production is an intermittent process. To overcome this difficulty a

split chute was designed from the secondary sinter screen which will permit material to flow to the hearth layer bin only as needed. A high and low level switch using isotopes will be installed in the hearth layer bin to control the conveyor located directly beneath the split chute. As the bin calls for $+\frac{3}{8}$-in., $-\frac{3}{4}$-in. material, the conveyor will continue to run. When the bin is full the conveyor will stop, the chute will fill and overflow the material onto a conveyor which is continually feeding the product bins on the high-line. Thus, at times, all $+\frac{1}{8}$-in. sinter will become blast furnace charge material.

To service the multitude of conveyors, screens and various pieces of equipment in this area, an elevator has been incorporated in the plant design. This elevator, with a 5 ft-4 in. x 8 ft-0 in. floor, has a capacity of 4000 lb. This size and capacity will allow the maintenance people to load any of the motors or speed reducers in the building, with the exception of the two large motors and reducers on the top floor, onto the elevator to be taken to the main floor which will be used for spare equipment storage.

In addition, above each piece of equipment which is too heavy to handle by hand, a small I-beam monorail is being placed. The convenience in changing equipment, it was felt, would play a vital part in the final quality and quantity of the plant production.

Not only will the elevator and monorails play an important part in maintaining production, they will also lend themselves to a better safety program. The days of bull work and bars are fast coming to a close with the advances of modern equipment.

The two largest motors and speed reducers, located on the top floor will be serviced by a special monorail which will enable this equipment to be lowered down the outside of the building.

The screening station structure, as is true for the entire plant, will be covered with corrugated sheeting, but unlike most buildings of this nature, no windows will be used. Instead, louvers are placed at convenient locations for ventilation and transparent plastic corrugated siding panels will be used for illumination. All the remaining exterior will be covered with galvanized sheeting permanently coated with baked plastic. It is believed with this design building maintenance can be kept at a bare minimum.

For ventilating purposes there will be two power roof ventilators capable of moving 5500 cfm of air. Using the louvers to control the air stream, the operators will be able to ventilate any part or all of the screening station.

The miscellaneous material track hopper is located adjacent to the main building at ground level. See Figure 6. It has been provided with two 100-ton hoppers to receive materials to be crushed or conveyed to the storage bins in the main building. Beneath these hoppers, which have a cutoff gate for control of flow and maintenance, are two variable speed vibrating feeders. These feeders deliver the material to a 36-in. belt. It is then conveyed to the screening station for processing. A mobile car shakeout was purchased for this hopper to assist in unloading, particularly during the winter. A car mover completes the equipment in this area.

SINTER MACHINE

The machine is 8 ft-0-in. wide by 168 ft-0-in. long, with 1344 sq ft of grate bar area and 21 wind boxes. The pallets are designed with a patented sliding seal to keep air infiltration to a minimum. The grate bars are of alloy metal. The side plates are 18 in. high with provisions on the machine to allow 22-in. side plates if found that a thicker bed would be advantageous. The machine speed is variable from six to 15 fpm.

The drive is two 75-hp motors with reducers and dynamatic clutch to drive both sides of the machine simultaneously. The teeth on the main drive sprocket are replaceable or can be repaired as needed. A hold-back or retarder sprocket has been installed on the return rail to keep the pallets snug, back to the main drive. This will eliminate bumping and keep the peening of pallets to a mimimum.

The feed end of the machine is comprised of a brick-lined hearth layer bin and an oscillating belt feeder, with electrodes placed on the slope of the material to regulate the speed of the machine automatically.

The main control desk located adjacent to the ignition burners is completely enclosed. A mimic panel

Figure 5 — The screening for the entire operation is housed in a single building.

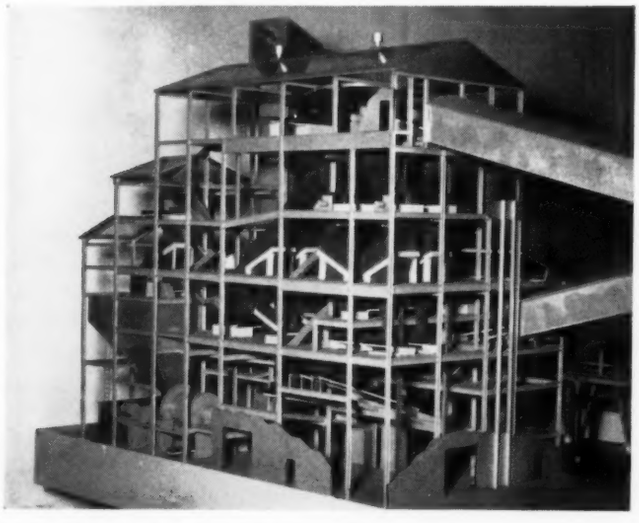
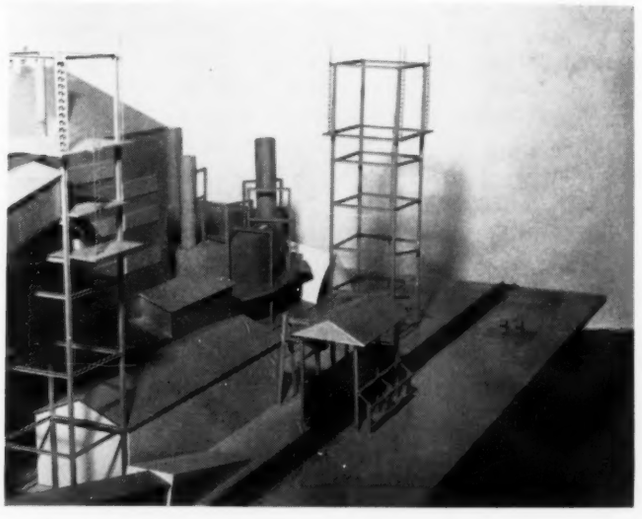


Figure 6 — This miscellaneous material track hopper is located adjacent to the main building at ground level.



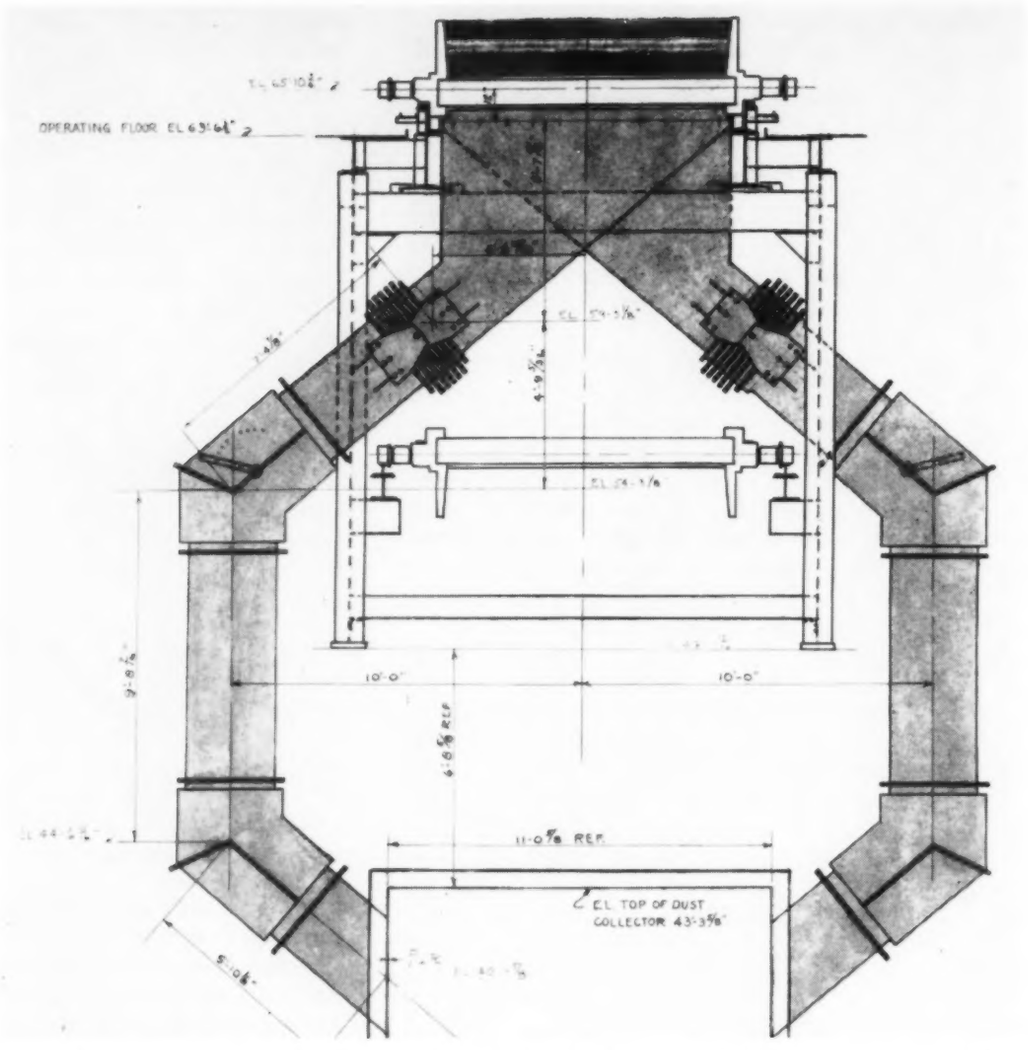


Figure 7 — This section through the machine shows alternate wind boxes.

along with complete draft and flow gages is on the back board. The console, facing the machine, will enable the operator to watch the machine and controls together. All switchboards will be totally enclosed in an airconditioned, aircleaned room with plate glass in front to allow maximum visibility.

The supporting structure on the discharge end of the machine is water-cooled. A dust collection hood will completely encompass the crusher, hot screen and grizzlies. A feature of this portion of the machine is that both the hot screen and the sinter crusher can be removed as units. With this design, the maintenance crew can remove the unit and replace it with a repaired spare with a minimum delay to the machine.

From the experience gained on the two existing machines, it was found that the elbows and duct work leading from the wind boxes to the large chamber beneath were constant sources of maintenance. With this in mind, the design engineers enlarged these elbows to accommodate a silicon-carbide refractory in brick form. The large chamber of settling chamber beneath the machine will not be lined, but will be painted on the inside throughout. After one week of operation the machine will be shut down and the chamber inspected. Wherever the paint is found to be gone, wearing plates will then be installed.

The main dust collecting system will be a combination of an electrostatic precipitator and dustcatcher with an overall efficiency of 98 per cent.

The main ore fine storage bins are large enough to hold 16 hours of maximum production. The coke and miscellaneous bins are approximately the same capacity. Mixing will be accomplished by two flying saucers using a swinging spout for equal distribution of the burden to each.

A second elevator will be installed in the main building.

HOT SCREENING

Of general interest will be the method of hot screening to be built into this plant. After the sinter passes through the crusher at the discharge end of the machine, it falls onto a natural frequency vibrating conveyor type screen located at 90 degrees to the machine. The coarse sinter then passes to a second conveyor for transmittal to the cooler. The hot fines drop onto a third conveyor for placement on the sinter cooler product headed for the screening station. Thus, a hot fines bin with its inherent problems is eliminated. Should the hot fines for any reason prove troublesome, they may in addition be steam or water-cooled.

ALTERNATE WIND BOXES ON MACHINE

In 1930 when Inland's No. 1 machine was built, the wind boxes were all designed to drop out on one side. Difficulty was experienced during operation with

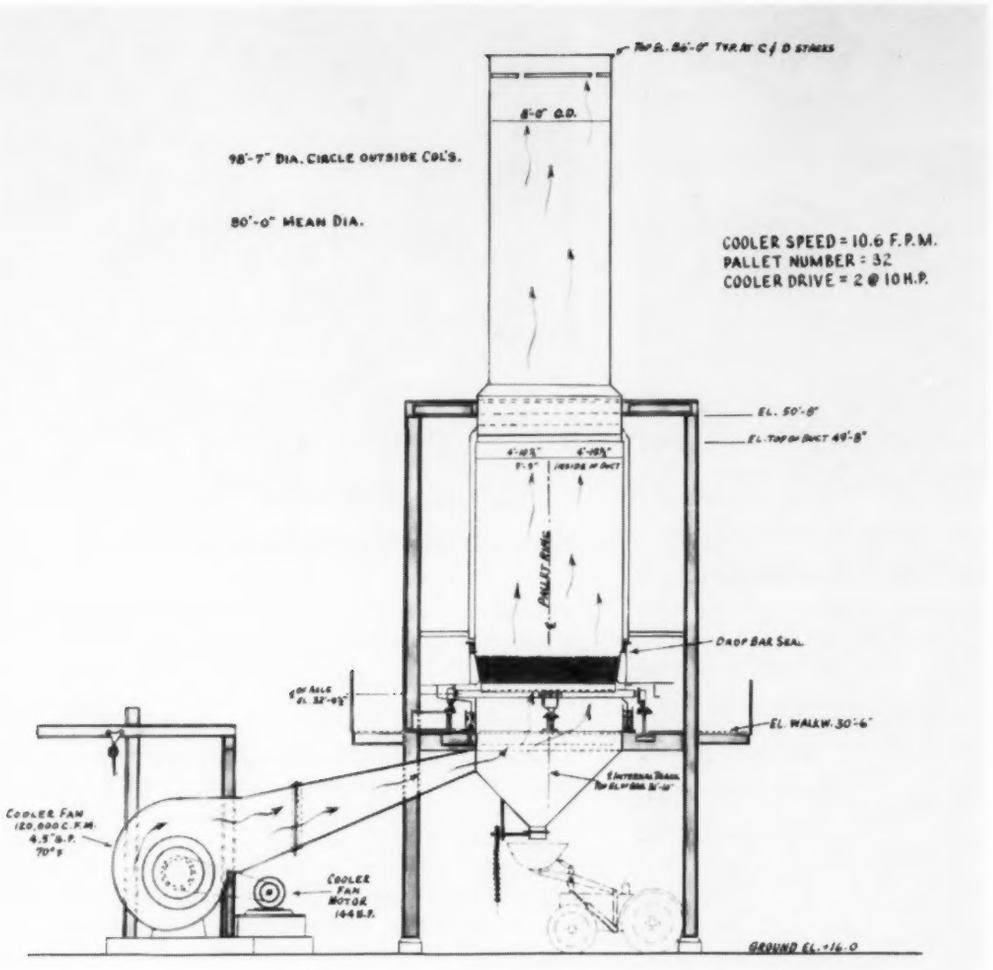


Figure 8 — A circular cooler with a mean working diameter of 80 ft will have air supplied by four 120,000-cfm forced draft fans.

the pallets skewing to the same side. Eventually this was corrected by shimming up this rail, thereby balancing the heat and suction. In 1943 when No. 2 machine was built, the problem was considered and it was decided to alternate the wind boxes. Although this was a radical change in design, the solution was effective and there has been no skewing of pallets. The same construction is being used on the new machine. Figure 7 is a cross-sectional drawing illustrating this arrangement.

MAIN SUCTION FAN

The quantity of air necessary for the combustion of fuel is governed by the amount of fuel and the speed of the machine. A good deal of time was spent at Inland's Research and Development Dept. on the two present machines to determine the air necessary to obtain proper combustion per square foot of grate bar area. The results of this work showed that only a certain amount of air passing through the sinter bed is beneficial to sinter production. Anything over the optimum will have a tendency to cool the sinter. Allowing for some infiltration and leakage, 325 cfm of air per square foot of grate bar area was considered adequate for maximum production.

The main fan will be a single width, double inlet fan, with a $\frac{3}{8}$-in. housing and inlet boxes, both split for convenient impeller removal. The housing will be provided with access doors for inspection. The impeller consists of ten forwardly curved, backwardly inclined replaceable alloy blades $\frac{1}{2}$ in. thick. The shaft is of forged steel and will ride in two ring-oiled, water-cooled, self-alining babbitted sleeve bearings. Scroll lines will be installed in the housing and will extend 12 in. up the side of the housing. These liners will be $\frac{3}{8}$-in. mild steel plate. The performance of this unit will be 440,000 cfm at 900 rpm giving a 35-in. suction at 350 F. The power for this fan will be a 3500-hp motor.

In order to avoid overloading this unit, automatic dampers will be provided on the inlet duct work.

SINTER COOLER

A circular cooler as shown in Figure 8 with a mean working diameter of 80 ft will be used to cool the sinter. The cooling air will be supplied by four forced draft fans each with a capacity of 120,000 cfm.

The cooling grates traveling counter clockwise drop the cooled sinter into a brick lined bin with the back of the bin lined with rails to absorb the initial shock load. From this bin the sinter is fed onto a belt by a variable speed vibrating feeder and an overflow chute. The feeder will operate faster or slower as commanded by the cooler. It can also be operated independently if so desired.

Beneath the traveling pans is a large chamber into which the cooling air is blown. Under this chamber and directly connected are 12 hoppers to catch the dribble, with a valve arrangement on each for periodic cleaning. These valves are high enough from the ground to allow

mobile equipment to pass under and to catch the sinter fines which are then to be put back into the system via the dust belt.

The retention time of the sinter during normal operation will be about 23 min. The cooler is designed to discharge the sinter onto the belt at less than 200 F.

SUMMARY

As the result of extensive investigation of existing and new sintering plants by the Inland engineering and operating personnel and the designer, it is felt that this new plant will bypass some of the known pitfalls that have been encountered in the past.

Although the speed of progress in this field is difficult to measure, it is understandable that each new plant will have definite advantages over the ones built previously. ▲

"LAYOUT AND DESIGN OF THE ASHLAND SINTERING PLANT"

by Richard W. Adams,

Area Engineer—Blast Furnaces and Foundry,

Ashland Works,

Armco Steel Corp.,

Ashland, Ky.

THE Ashland sintering plant is neither the world's largest nor the most automatic, but as a modern plant, capable of handling several raw materials and designed to furnish sinter for three separated blast furnaces, it is expected to be a very useful and economical tool. Designed to produce a normal capacity of 2400 or 3000-ton per day maximum, the plant originated as an answer to the need for agglomerating Labrador ore and will largely pay for itself by reclaiming an accumulated store of flue dust and sludge. It is the first sintering plant of its type to be built in this country and required an unusual amount of engineering skill to lay out because of the complexity of the material handling system and the limited space available.

Figure 1 — An aerial view of the plant shows its location between elevated tracks.

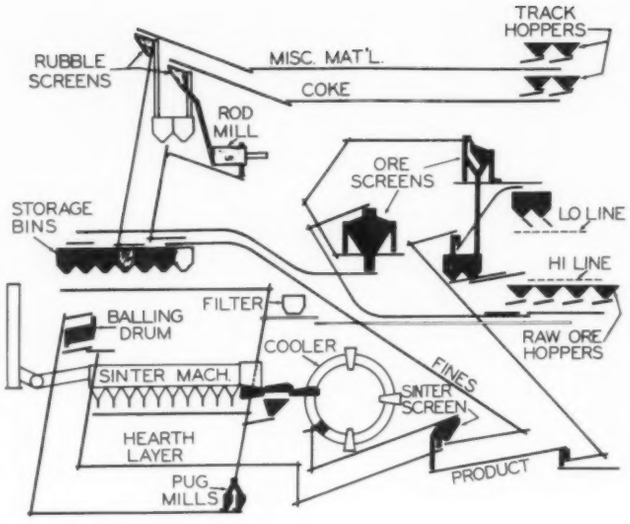


Figure 2 — Material flow diagram of the plant.

PLANT LAYOUT

Ashland's three blast furnaces were built by different companies at locations approximately a mile and a half apart. The Sixth Street furnace, with a present hearth diameter of 13 ft-9in., was originally built in 1869, while Norton furnace was built in 1873 and now has a hearth diameter of 14 ft-6 in. Bellefonte furnace was built as an addition to the main plant in 1942 and has a hearth diameter of 27 ft-3 in. Since the two small furnaces do not have ore bridges, it was decided to build the sinter plant at the end of the existing ore yard at Bellefonte furnace and to provide means for moving sinter and large ore to these furnaces by rail. This also meant that the material handling equipment, both at the ore yard and at the sinter plant, would have to handle all the Labrador ore for the three furnaces.

The main part of the sintering plant is located in a triangular area bounded by two elevated tracks approaching either side of the ore yard and the end of the yard itself. Since the yard is only 185 ft wide, some parts of the plant were located on the other side of the highline approach trestle as shown in Figure 1.

RAW MATERIAL HANDLING SYSTEM

Equipment for handling raw materials is designed to receive and store a day's requirements in eight hours. As shown on the flow sheet in Figure 2, raw ore is dumped by the blast furnace transfer car into four hoppers under the highline, Figure 3, and fed by vibrating feeders onto conveyor belts which take it to the primary screens. Ore fines passing through the $\frac{3}{8}$-in. mesh screen are conveyed to the top of the raw material storage bins in the main sinter building, and a shuttle conveyor puts them into one of three bins. Ore passing over the screen may go to three places: a storage bin over the highline, a bin over the yard level track for subsequent movement to one of the other two furnaces, or finally, to a secondary ore screen to obtain +1-in. material for the open hearth.

Figure 3 — At the bottom of the raw ore hoppers are vibrating feeders.

Over the years the accumulated dry flue dust from the blast furnace dustcatcher and the wet flue dust, or sludge, from the wet washing system, have been stored in several piles near the blast furnace. These materials are loaded into hopper cars and dumped into two track hoppers at yard level as shown in Figure 4, fed by belt feeders onto a conveyor and sent to a rubble screen. From here they go to another shuttle conveyor and into any of three raw material bins, one of which is a swing bin used either for ore or flue dust. Miscellaneous materials such as limestone, mill scale, etc., will be handled over this same system when they are used.

A parallel set of track hoppers, belt feeders and rubble screen are used to bring coke breeze to the rod mill, where it is crushed to a particle size of $-\frac{1}{8}$ in. Conveyors then take it to its storage bin in the main building.

The fourth raw material to be stored is the return cold sinter fines which have been screened out of the sinter and conveyed to the bin.

PREPARATION OF THE SINTER MIX

Preparation of the raw materials for sintering is accomplished by the conventional pug mill and balling drum. Fed onto a belt by 96-in. table feeders, Figure 5, the iron-bearing materials (ore, flue dust, return sinter fines) are totalized by a belt meter and a proportionate amount of coke is added, a second scale then recording the new total. As the raw material is then conveyed to the pug mill, several other materials, which by nature are difficult to handle otherwise, are dropped on top of the mixture. The first of these is the current sludge produced by the Bellefonte furnace gas cleaning system which has been settled in a 90-ft diam thickener, shown in Figure 6, installed as part of the sinter plant construction. The slurry from the bottom of thickener is pumped to vacuum disk filter and deposited on the raw material belt as filter cake. Next to be added is the dust and accumulated spillage from the sinter machine, fed onto a dust belt from chutes with motor-operated dust valves. Lastly, the hot fines, falling through the vibrating screen that feeds the sinter cooler, are fed onto the raw material by a vibrating feeder.

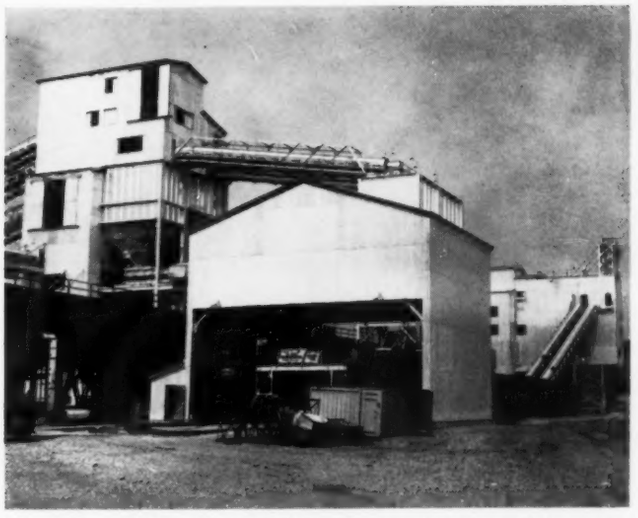


Figure 4 — Coke and miscellaneous material track hoppers feed material onto conveyors shown entering the rubble screen building at the right.

Figure 5 — Bottom of the raw material storage bins shows arrangement of table feeders.

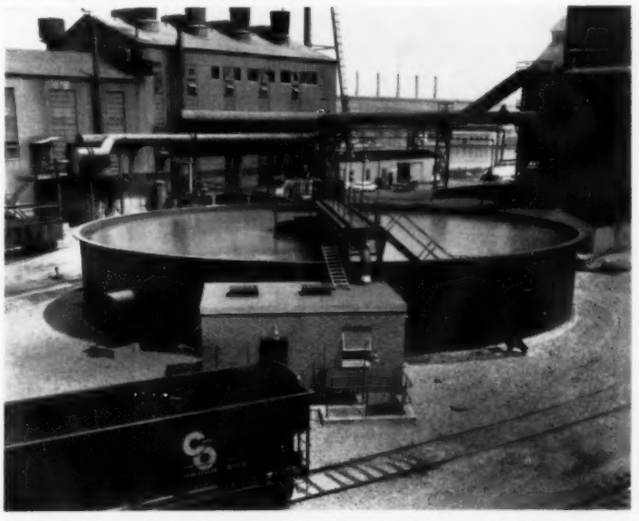


Figure 6 — The slurry from the bottom of this sludge thickener is pumped to a vacuum disk filter and deposited on the raw material belt as filter cake.

Sufficient water is added in the pug mill to quench the hot fines and to promote proper mixing, after which the pugged material is sent to the balling drum. Final adjustment to the mix is made in the drum with the

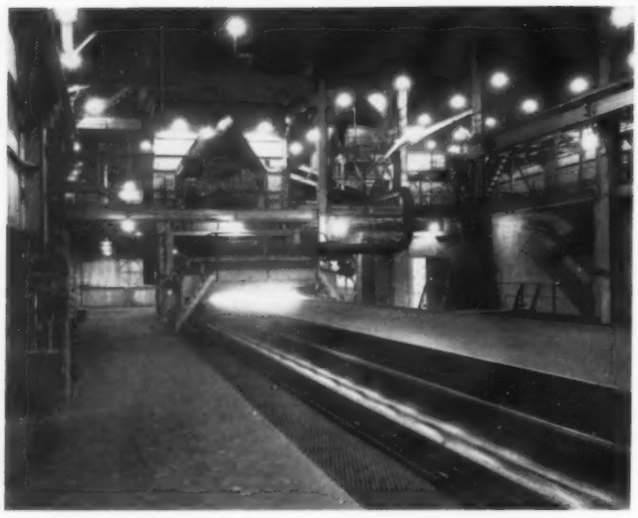


Figure 7 — This view of the sinter machine from the feed end shows the balling drum in the background.

addition of enough water to give the desired consistency and pellet size. An equalized distribution of the various particle sizes in the mix onto the sinter machine is achieved by using an oscillating conveyor to feed the material into a trough or hopper over a roll feeder. The bed of material then passes under a hood type ignition furnace which provides 30-sec ignition time and uses natural gas as fuel.

SINTER MACHINE

Manufactured in this country under a license, the sinter machine, Figure 7, has a maximum bed depth of 14 in. and an active hearth area of 807 sq ft. Pallet width is 8 ft −3 in., and the active length is 97 ft −6 in. with 15 windboxes, and the machine is driven by a 50-hp d-c motor at speeds up to 17-$\frac{1}{2}$fpm. The main sinter fan will handle 200,000 cfm of air at 390 F, and maintain a suction of 35-in. water column at the bed. A special feature of the machine is the continuous grease seal between the pallets and the framework of the machine which eliminates most of the wasteful leakage around the machine. Another feature is the vibrating feeder located inside the discharge end of the machine which picks up the fines falling through the grates and feeds them back into the sinter coming through the crusher.

Figure 8 — The circular cooler vibrating feeder at the left center discharges material onto pallets which move clockwise under the three fans and discharge the sinter on the conveyor at the bottom left.

SINTER COOLER

Two large vibrating feeders and a vibrating screen are used to load the hot sinter onto the cooler. The vibrating screen serves to remove the hot fines and permit better cooling as the sinter travels around the circular cooler, Figure 8. Three fans draw 150,000 cfm of air apiece up through the bottom of the 7 ft-0 in. wide pallets and discharge it into a common stack as the material moves around at speeds up to ten fpm. The cooled sinter then slides into a hopper from which a vibrating feeder loads a conveyor going to the sinter screen.

SINTER DISTRIBUTION SYSTEM

Three separations are made on the double deck screen: the $-\frac{3}{8}$-in. sinter is returned to a raw material storage bin, $+\frac{3}{8}$ in. to $-\frac{3}{4}$-in. material is used as a hearth layer and the $+\frac{3}{4}$-in. sinter goes out as product. Provisions were originally made to regulate the amount of hearth layer material sent to the machine by using a flop gate to divert it onto the sinter product belt if the hearth layer hopper was full. This system proved very difficult to operate because of the frequent switchings required of the flop gate and excessive wear caused by the sinter falling on the gate. In order to overcome this, a restriction, similar in principle to an adjustable orifice and composed of three horizontal sliding plates, was placed in the bottom of the chute feeding the hearth layer conveyor, and the flop gate was taken out. By adjusting the sliding plates, an opening is obtained which allows a desired amount of hearth layer material to pass through onto the belt at a constant rate. The excess material then builds up in the chute and overflows into the chute feeding the product sinter belt, and because the hearth layer chute stays filled, it acts as a stone box to prevent wear. Since this material is dry, hard and of a uniform size, it flows freely through a small opening and permits very accurate and flexible control. Product sinter can go to any one of three locations: a storage bin over the highline for removal to Bellefonte furnace, a bin over the yard-level railroad track for distribution to either of the other two furnaces, or, if for some reason these two bins are full or it is necessary to work on one of the conveyors, it can be stored in the end of the ore yard.

DUST COLLECTION

In an effort to relieve the dusty conditions that prevail at most sinter plants, three separate dust collection systems were installed. The main system cleaning the gas going to the sinter fan consists of five multiclones on the discharge end windboxes, ten "S" type separators on the other windboxes and one "policeman" type separator. This system is expected to clean the gas to 0.1 gr per cu ft or less. The second system picks up dust from the discharge end of the

Figure 9 — The predecessor of the new sintering plant was this 50-ton per day, pan type batch system plant installed in 1913.

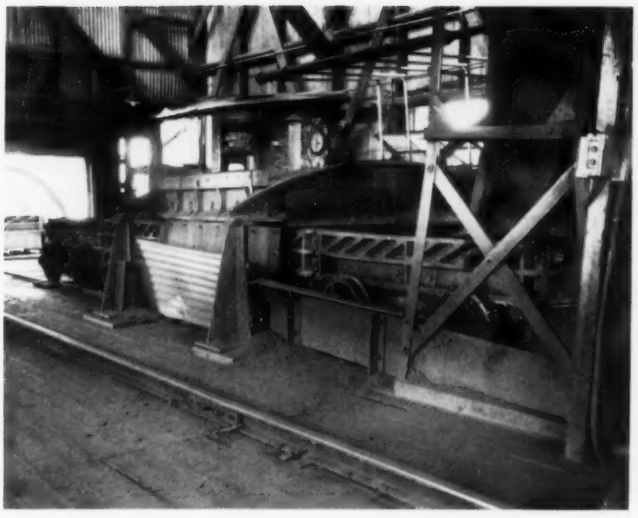


Figure 10 — This general arrangement of the old plants sinter machine shows its feed chute at the right, ignition hood in the center, and pans being cooled at the left.

sintering machine, the hot sinter feeders and the circular cooler loading and discharge points, and consists of a multiclone system. The third system, also a multiclone, picks up dust at the sinter screen and several transfer points of the sinter handling system.

ELECTRICAL POWER SUPPLY

Power for the sinter plant is supplied by a 500,000-circular mill line carrying 6900 volts from the main mill substation to two 1000-kva substations where it is stepped down to 440 volts. From here it is distributed to seven control centers, each of which is arranged with a cascaded system of controls to prevent pile-up of material in case of individual equipment failures. Total connected horsepower for the plant is 3477 including the main sinter fan which is driven by a 1750-hp, 6900-volt squirrel cage motor equipped with a reactor type starter. The d-c power for the sinter machine and cooler drives and the table feeders is supplied by individual motor-generator sets. A bank of storage batteries provides for emergency lighting and tripping of breakers. One of the most valuable parts of the entire plant is the communication system with paging telephones located at 21 key points.

COMPARISON

In contrast to the plant described in the preceding discussion, Figures 9 and 10 show its predecessor at Ashland. Located in a separate part of town, most people were hardly aware that it existed, but since 1913 it had been used to sinter about 50 tons of flue dust a day from the two small blast furnaces. As far as can be determined, only two of these plants were ever placed in operation, but using a pan type batch system, it faithfully made what was sometimes laughingly called sinter three turns a day, seven days a week—at a substantial profit. Originally installed in a wooden building, most of which still remains, and made up of only the barest of essentials, it nevertheless, in terms of return per dollar invested, set up an outstanding goal for its successor.

Discussion

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M. C. Stafford. In this era, with steel mills using increasing amounts of foreign ores containing high percentages of fines, with the increased utilization of

concentrated low grade ores, with the increased emphasis on prevention of air pollution, and with the increased use of sinter burden to obtain maximum production from existing plants, the importance of sintering plants to steel mill operations continues to increase at a rapid pace.

The papers that have been presented illustrate the careful study and planning that must go into each plant; careful planning by the steel mill operators, the plant constructors and the equipment manufacturers.

Each of the authors outlined the elaborate dust collection systems being installed to prevent air-pollution. Certainly the prevention of air-pollution in the steel mill operation is important, but the economics of the recovery of raw materials through dust collection and sintering was illustrated by Mr. Adams in his opening paragraph when he stated that the Ashland sintering plant will be largely paid for by reclaiming an accumulated store of flue dust and sludge.

The increased importance of the sintering plant places greater and greater emphasis on the need for reliable, rugged machinery. Mr. Watson outlined how some of the equipment at Weirton No. 2 sintering plant is mounted on motorized carriages to facilitate maintenance. Mr. Watson and Mr. Loofboro mentioned complete standby units at critical spots to keep down-time to an absolute minimum.

This need for reliability and rugged design is nowhere more obvious than on speed reducers, whether they be for conveyor drives, machinery drives, feeder tables, car pullers or whatever.

We are gratified that we had the opportunity to furnish the feeder tables, conveyor drives and machinery drives for the Inland Steel sintering plant and also the conveyor drives and machinery drives for Weirton Steel.

In the selection of the drives for any sintering plant, we feel that the following points deserve special consideration: proper selection of reducer rating; adequate sealing; and over-all reducer design. During the selection of the speed reducer rating for a given drive, the actual transmitted load, the horsepower and complete torque characteristics of the driving motor and adequate service factor must all be carefully considered. Sealing around rotating shafts against the entry of abrasive dust into the gear box is particularly important in a sintering plant. In the many years we have furnished speed reducers for sintering plant service we have found that a spring-loaded lip type seal backed up with a felt washer and seal plate gives adequate protection for horizontally extended shafts. The sealing of the vertically extended shaft, however, is considerably more difficult. For vertical shafts, such as found on feeder tables, we have found that excellent results are obtained from a combination of a double lip type seal backed up by an umbrella and grease labyrinth seal.

From a design standpoint, surely wherever possible, totally enclosed gearing should be used. It has been our experience that the balanced design parallel shaft, herringbone speed reducer gives maximum efficiency with the least maintenance costs for the majority of machinery drives.

For feeder tables we have found that a spur gear set or helical gear set for the final gear reduction gives the best result. We have found that by positioning the right angle gear seat in the gear train preceding the final reduction that either a worm gear set, limited to a relatively low ratio, or a spiral bevel gear set will give good results. Refinements in feeder table design such as the use of pressure switches, visual flow meters and oil filters in the auxiliary lubrication system are also important.

The success that sintering plants have enjoyed with this type of feeder table design can best be illustrated by a study that one of our engineers made recently on spare parts which we have sold to our feeder table users on all tables installed since 1932. This study indicated that our feeder table users had used an average of $0.68 worth of spare parts per feeder table per year of operation.

To summarize, I would like to re-emphasize that proper consideration given to reducer rating, a proper service factor, sealing arrangement and over-all reducer design when selecting drives for sintering plant applications will pay handsome dividends in years of trouble-free operation.

A. A. Nilsen. In reviewing Mr. Adams' paper, I would like to clarify or expound a little bit on the design. As stated, the area in which this plant was built was very narrow and anyone looking at the plant would question why so many conveyors. In order to deliver the ore from the highline receiving bins to the screening station, which is adjacent to the highline, the ore travels over two inclined conveyors to obtain the necessary elevation. The oversize ore, which must be delivered to bins above the highline, also requires two inclined conveyors to obtain elevation. Since the Armco plant has provisions to load out oversize ore into railroad cars or to an emergency stock pile, additional conveyors are required; so, due to the narrow area, many conveyors are required to gain elevation.

The diameter of the table feeders under the storage bins are 8 ft-0 in. instead of 7 ft-5 in. as reported in Mr. Adam's paper.

Mr. Adams stated that the sinter is passed through a roll crusher. We do not like the term crusher, as we do not want to crush sinter; we want to break it and therefore prefer the term sinter breaker. In fact it is not a roll type breaker, since we are breaking the sinter through grizzly bars with approximately 8-in. openings, by hooked arms, mounted on a rotating shaft. These arms break the sinter over the grizzly and push it through to the hot screen below. In this way a minimum of fines are made by breaking the sinter cake as it is discharged from the machine.

Someone else talked about controls for the water which is added at the pug mill, balling drums or disks. At Armco we have a similar air-electrical control. The sintering machine operator, from his control panel, can vary the water at either the pug mill or balling drum. Instruments are provided to both indicate and record the volume of water being used. This has eliminated any guesswork as to the quantity and gives the operator infinite control. The quantity of water which must be added to the mix depends upon the raw materials. At Armco it is necessary to add between 20 and 35 gpm. Most of this water is added at the balling drum. The principal reason for adding the largest quantity in this mill rather than at

the pug mill is to reduce the pug mill blade wear, which seems to be accelerated by large quantities of water. At Armco the hot sinter fines are added before the pug mill.

We recently put into operation the McLouth Steel Corp. sintering plant. At this plant the hot fines are added after the pug mills. This method created a problem of preventing the hot fines from coming in contact with the rubber belt at the next transfer point. It required baffles in the transfer chute and plows on the belt to mix the hot fines with the other materials and eliminated direct contact of the hot material with the belt on the following conveyor. Mr. Frame, in his paper, mentioned that they were planning to put the hot fines on top of the sinter from the cooler. I question whether this would be the right thing to do. Due to the vibrations set up by the conveyor troughing idlers, the hot fines would soon be at the bottom, next to the belt. Quenching the hot fines before putting them on the belt would of course eliminate burning of the belt, but might introduce other problems in the system.

At Armco we use a hearth layer. As originally designed it was necessary to take all or none of the size fraction between $\frac{3}{8}$ and $\frac{3}{4}$ in. back to the sintering machine. We soon found out that this was not a workable system as it required close supervision and overloading of conveyors. The system was revised to provide an overflow, to produce a side sinter, not required as hearth layer. Provision was also made to control the quantity being fed back to the sintering machine. It is surprising how much good sinter falls into the size fraction used for hearth layer, and therefore provision must be designed into the system to automatically divert a portion of this size to product.

Robert E. Powers: We have heard a description of the design and initial operation of the first 12-ft sintering machine plant to be built for iron ore sintering. Weirton and Great Lakes, needing large tonnages of sinter and encouraged by the successful performance of the first 8-ft wide sintering machine plant in the United States, took a hard look at the 12-ft machine operation at Blackwell Zinc Co., Blackwell, Okla., where zinc concentrates are treated. Faced with space limitations and realizing the prospect of low unit operating costs, they chose to build their additional sinter tonnage in single-machine units. These plants are astounding in their size. No effort has been spared in the sintering machine or in any of the auxiliaries to provide sufficient capacity and ruggedness to cope with the large tonnages which must be processed.

The flow sequence in this plant is new and has not been duplicated in its entirety in any other plant. Particularly notable are the raw material circuit and the sinter handling facilities.

In the raw material circuit, all materials, including hot returns, are mixed in a rotary drum pug mill. This is an enlarged version of the well known drum pug mill common in sintering plants of older design. The mix then passes through a balling drum for seed pelletizing by addition of water. The permeability characteristics of this prepared feed are preserved by careful handling from this point to the sintering machine. The mix is spread across the 12-ft width by a reciprocating conveyor and deposited onto the grates by a roll feeder. All materials entering into the raw material flow are small in size, the largest being the screened ore of $-\frac{3}{8}$-in. size.

Special attention has been given to the handling of sinter from the sintering machine all the way to bins on the highline since this is the section of the plant which is subject to the most serious abrasion, dust, and temperature problems. The huge hot sinter cake falls off the machine onto a crash deck and into a slowly revolving breaker. This breaker, which has removable teeth, presses the sinter through a bank of bars in order to break it into pieces for effective cooling. The broken sinter falls onto two parallel hot sinter screens where hot fines of small size are screened out effectively over a rugged grizzly-bar deck. The screens are on a slope so that the hot sinter spreads out one layer thick and rapidly passes off. A unit of this type has now been in successful operation in another sintering plant for 12 months. The hot screened sinter falls down a chute onto the straight-line sinter cooler. This cooler, which mechanically is every bit as rugged as the sintering machine, uses a forced updraft of air and the hot air from the top of the bed exhausts to the atmosphere without any hood or stack since the dust has been effectively removed in the hot screening. The cooled sinter is screened over one double deck cold sinter screen for separation of hearth layer and for final removal of small cold returns.

Initial operation of this plant and of its sister plant at Great Lakes Steel Corp. gives every indication that the original intentions of National Steel management will be fulfilled in providing low unit capital costs, low unit operating costs and low unit maintenance costs.

M. F. Morgan: It is very interesting to me—and I know you men are interested in seeing a sintering plant that was built in 1913, there are very few of us left who were working in the sintering game at that time, and the evolution of sintering plants has gone far beyond any expectations that we ever had.

Starting with the 42-in. wide machine, 23 ft long in 1913, we jumped in 1925 to a 6-ft wide machine. This machine was developed up at Lion Mountain, New York and I do not believe from that time until this present era that any machines over 6 ft wide were installed in the ferrous field in this country.

Then in 1955 we jumped to an 8-ft wide machine and a lot of old operators wondered, how are you going to operate with those big heavy pallets; what is your repair and maintenance going to be?

Well, we did not get our feet on the ground until in 1957 we went to the first 12-ft wide machine in the ferrous field in America. If I am not mistaken, there are only two plants in the iron industry that have 12-ft wide machines at the present time.

I have been to Weirton to see their plant. Nobody has mentioned the narrow space that was allotted to build this plant—what has been accomplished is quite unique. The sinter and the raw materials are taken back and forth due to the location, and fundamentally there is nothing wrong in this plant.

Now, I was not a 12-ft wide machine advocate but there it is. A lot of things had to be ironed out due to location; a lot of tranfer points had to be corrected and also a lot of other correction had to be made but none

that are insurmountable for the operation of a 12-ft wide machine.

I believe at the present time the 8-ft wide machine and the 12-ft wide machine for the vast tonnages that we are talking about at the present time and the beneficiation of iron ores will become standardized.

Patrick V. Gallagher: Mr. Frame mentioned that we designed Inland's plant to avoid the pitfalls which have gone before. Of course, we did try to do that, but I am sure that we are going to discover brand new pitfalls that nobody ever hear of.

I think that some explanation is in order with regard to the reasoning behind the hot fines handling system which will be installed at Inland.

Some time ago, in the early part of the United States Steel sintering program, our research laboratory ran a series of tests in conjunction with U. S. Steel Applied Research Laboratory on the advisability of putting hot fines before or after the mixers. The consensus of opinion was that with the hot fines added after the mixers, an 8 per cent increase in production was possible.

At that time hot fines were going to be screened at $\frac{3}{8}$ in. as was intended at the Fairless sintering plant. Not very long after Fairless went into operation, it became apparent that screening at $\frac{3}{8}$ in. flooded the operators with hot fines and, consequently, the decks were changed to $\frac{3}{16}$ in. and the available screening area reduced considerably.

When this change took place a point was perhaps missed, which is that permeability attributed to hot fines in the bed was largely due to the larger sizes of hot fines and not primarily by virtue of the smaller sizes.

With hot fines now being screened at $\frac{3}{16}$ in., we feel that there is no economic necessity for introducing them after the mix, thus creating some of the pitfalls that Mr. Gordon Baer mentioned, such as burning conveyor belts, etc. There is no longer any economic reason for not placing hot fines either in the mixers, or better still, eliminating them from the circuit altogether. Elimination of the hot fines from the circuit gets rid of one of the variables detrimental to the production of a chemically constant mix and, therefore, consistent sinter.

After review of this situation with the Inland engineers, we jointly determined that the way to handle the hot fines was to place them on the sinter product going up to the screening station and return all sinter fines through one system which could be controlled, namely, the cold fines return bins.

We are quenching the hot fines to avoid burning the product belt, of course, and attach little importance to the loss in thermal value thus established. These remarks may clear up some of the questions which you may have about this method of handling. However, we are open to further discussion, if you wish.

I would like to mention that in the Inland plant there is no primary mixer. However, similar to the U. S. Steel installations, all mixing is done through two flying saucers. I might point out to the Ashland and Weirton people that we will replace your pug mills with these machines at any time.

In the Ashland paper and in the Weirton and J & L papers, as a matter of fact, we notice one piece of material handling equipment being used which leaves us rather baffled.

During the design of the Ohio Works plant and again during the design of the Inland plant and in conjunction with Inland's engineers, we had a discussion about what type of feeder should be used to deliver ore from the track hoppers to a conveyor belt. We polled the industry and talked to people who were using vibrating feeders (the electromagnetic vibrating type), 13 of them all told. It is rather interesting to note that only two of the users to whom we spoke felt that the electromagnetic feeders were doing the job; ten were willing to spend money to replace them with a more positive type of feeder; one had no opinion at all. The general objection was, as you might expect, material build-up.

Yet in spite of this reaction, we see new plants being proposed and new plants being built currently using electromagnetic vibrating feeders for feeding ore from track hoppers.

I do not know what kind of ore you fellows are handling—perhaps we are just unfortunate in the type of ores which we have been handling recently, but we never can feed a wet sticky ore with this type of vibrating feeder. For these reasons we went to the oscillating conveyor in the Inland plant. Incidentally, this was not an experiment on our part, since we went up to the iron range and talked to the people who handled the stuff right where it comes out of the ground. We saw these machines in operation, and they were doing a fine job.

Of course, for dry, fine and granulated material, the electromagnetic type of feeder is fine.

Perhaps we could get a discussion going on this subject, since the feeding of material is an essential part of a sintering plant operation. I would certainly like to hear some other views on this.

Another rather interesting item in the Inland plant, and it is quite different from what is used in the Weirton, Ashland or J & L plants, is the elimination of the swinging spout and roll feeder for feeding the sintering machine.

If you have fluffed the mix in a mixer—that is, in a mixer that is capable of fluffing a mix, and I do not mean a pug mill—and you are going to feed that mix onto a sintering machine, there is not much point in banging it from a swinging spout to a roll feeder, then shearing it off with a strike-off plate above the feeder, then letting it free fall from the roll feeder to the machine and shear it off again.

There is even less point to putting in a swinging segregator, or rather, a swinging spout, for feeding a sintering machine.

We are using a swinging conveyor directly onto the machine and it is successful, except when we bring up hot fines and burn the belt as Mr. Baer has mentioned. We will lick that problem shortly, of course, but I fear that we will never understand such machines as swinging spouts, roll feeders and fluffers. We will probably continue to have a lot of trouble with such understanding.

We were very interested in the special feature of the Ashland plant, the sliding seal on the sintering machine. That wonderful invention is intriguing to us. As a matter of fact, it probably has taken more boat trips than any invention we know of. It started out here and

it went over to Germany and it came back again and now we hear that we have a brand new type of seal. Of course, the fact that it has been in use here for over a dozen years does not seem to change anything. It is quite true, however, that it does help eliminate wasteful gas leakage.

Incidentally, Mr. Baer is quite right in his statement that the seal will help keep your gas temperature above the dew point and allow you to use electrostatic precipitators. I think that if consideration and analysis is given to the reason why electrostatic precipitators are considered in a bad light in sintering plants at the moment, it is only because one has rotted out in the recent past. This was due to condensation, of course, and if the gas temperature had been maintained high enough in the first place, it would not have occurred. Therefore, if you are considering an electrostatic precipitator, you are almost forced into a sliding seal. We just happen to have one of those, too.

I have some questions which I will reserve for the panel discussion later, however. I jotted down some notes here as this meeting went along and will refer to them now.

In Mr. Adams' paper on Ashland, he showed a picture of the old sintering plant. Except for some conveyors instead of dragging those wheels around, I could not see very much difference in many of the newer sintering plants. You still dump the mix onto the machine after beating it up in a pug mill, then try to pull air through it and wonder why the vacuum is so high. Not much has changed in this respect.

We are certainly very much in agreement with the wet collection used at Weirton and wish that every plant that we work in had a thickener so that we could also go to that type of collection.

I think that just about covers my comments on these papers, except to say again that they were all very well presented and very interesting.

George W. Watson: We, of course, do use the vibrating feeders, and I do not know what ores you refer to as being granular; if any of you people in this room have, say, Labrador ore and Labrador ore fines, it is about as sticky a material as I think that you can find. A normal ore car is loaded with a pile at each end of a hopper car and when you take it to the car dumper at the plant it is still a distinct pile but I have seen Labrador ore come into our plant where the material has flowed together. It is one flat level car. The railroad trip has made it—well, comparable to over vibrated concrete. You will find that there are 3 inches of water on top and there are some of the extreme fines in the center and aggregate at the bottom in the pocket of the car, and when you turn the car over the water comes out.

We then go in with air spades and it may take us an hour to get it out.

Now, we have tackled this problem from all angles. We have asked every expert in the country how to get wet Labrador ore out of a car. Yet, we do not have any trouble with our vibrating feeders. I cannot comment as to why, but they work.

E. W. Fitch: I am particularly interested in the ignition furnaces. What optimum temperature and what optimum time is necessary for proper ignition? Also is it necessary to have more time or more temperature when making lime sinter?

George W. Watson: We are currently using coke-oven gas, 570 Btu. We have an eye at the top of our radiant arch, and we try to maintain approximately 2500 to 2550 F at the top of that arch.

Whether more or less heat is required for lime, I could not answer. We are using a percentage of lime, but we have used that from the start of the plant, so whether there is any difference between that and non-flux sinter I am not prepared to say.

Charles P. Frame: Prior to August, 1958, we had two burner ignition furnaces on our sintering machines, but in August a third burner was installed on each furnace. It is felt that there is a definite improvement in quality as well as quantity.

The retention time is now one minute and 30 seconds against one minute with the two burners. It seems, depending on the burden used, that somewhere between one minute and two minutes would be the optimum amount of time.

By using lime in the mix it is generally accepted that more heat or longer retention time is necessary.

Member: I would like to ask Mr. Loofboro this. I noticed in his paper that he is using both the flying saucers and two balling drums and that there is a by-pass for these machines. Is he now balling this material to increase the permeability of his bed and if he is not increasing the permeability or not balling, why?

K. S. Loofboro: Our ores are not of a type that we will normally pelletize. What actually happens when we use the flying saucer is that finer particles of ore adhere to the hot or cold returns. The returns act as a seed. We cannot say that we are pelletizing, we have not played with the flying saucers enough as yet to see if we actually can. Our so-called sintering ore is on the coarse side and when we get into our New York state concentrates or some other fine material we hope and anticipate to make some pellets. Putting the feed over the flying saucer does increase the permeability.

A. A. Nilsen: Yes, I just want to comment on the fact that we have a 13 ft-1 ½ in. wide sintering machine. You were talking about a 12-ft wide machine and our machine is four meters wide.

I also want to comment on Mr. Gallagher's statement about vibrating feeders. We have vibrating feeders at both the Armco and McLouth sintering plants. If the chutes onto these feeders are designed correctly, these feeders do a very good job. At McLouth we have feeders which were delivering 100 tons per hour of zero to 6-in. ore. By changing the chute design to eliminate the vertical load on the vibrating feeder these same feeders are now capable of delivering 300 to 350 tons per hour.

Richard W. Adams: We have had a great deal of trouble with Labrador ore sticking in vibrating feeders at our ore briquet plant, even to the point of packing them solidly enough to stop the vibration. However, the design of the chutes and feeder at the sinter plant has evidently been improved enough that we have no trouble there. A good part of the time we have water standing in our ore yard and we deliberately tried to find a moisture content in the ore that would cause it to plug the feeders, but neither then nor since have we experienced any appreciable difficulty.

P. Wilson: Those sinter coolers are almost as big

as the sinter plants. I wonder why we are spending so much time on these sinter coolers. Russia is supposed to be so far ahead of us and they do not use them. I realize the safety point in this but why are we spending so much time on sinter coolers when the Russians are using hot sinter? Why not use hot sinter; why not have ample stocking space?

William O. Bishop: Well, with our original sintering plant at Inland which has no cooler, the sinter does at times get a little warm. The larry car operators in the stockhouse do a lot of complaining and perhaps rightfully so. Consequently we have water sprays for the sinter bins. I believe that while some of the Russian plants are using hot sinter, there were a few comments made by some of the supervisors in Russia that they see no reason for it being charged as hot as it is being charged. It is just that they do not have coolers and so rather than stock it and so on, they transfer it directly into the stockhouse and use it. I also understand that some of their stockhouse scale cars have enclosed cabs which I believe are air conditioned so that their employees are not bothered the same as ours would be with an open scale car. Perhaps the day will come where we will charge it warm and perhaps save that heat also.

The only answer to ample stocking space is that many plants, including our own, just do not have the ore yard capacity.

W. H. Collison: The design, construction and operation of sintering plants has been of prime consideration at Great Lakes Steel for the past two years. The new plant, first operated in August of this year, is believed to have the largest sintering machine in the steel industry. Although Weirton's machine is a 12-ft machine and both were designed and built at about the same time, there are several points of difference between the two plants and also those described by Messrs. Adams, Loofboro, Bishop and Frame.

The Great Lakes plant was designed to give the furnaces a fully beneficiated burden, about 65 per cent sinter and 35 per cent screened, sized ore. In the future, when as much as 25 per cent of the total ore supply will be concentrates, the ratio of sinter and sized ore will be changed accordingly. A machine 12 ft wide, 199 ft-6 in. long, with 19 wind boxes was built. Nominal capacity is 7000 tons. It is believed that with self-fluxing sinter as much as 4 tons per sq ft of grate area per day can be made, or 9600 tons per day.

Zug Island, where equipment is at once congested and scattered, presented a difficult problem in the handling of ore, miscellaneous raw materials and sinter to and from a plant of this size. In contrast to the Inland with minimum conveyor belts, this plant has 82 conveyor belts, totaling seven miles.

These belts are:

1. Transfer ores from dock No. 1 or dock No. 3 to ore screening station or dock No. 2.
2. Transfer ores from dock No. 2 to ore screening station.
3. Transfer sized ores from screening station to ore bins for furnaces A, B and C, bins for furnace D, or to dock No. 2 or dock No. 3.
4. Transfer sinter to bins for furnaces A, B and C, bins for furnace D, or to dock No. 2 or dock No. 3.
5. Transfer miscellaneous materials from track hopper over a rubble screen to sinter plant.

Raw ore conveyors are 42 in. wide, 1250-tphr capacity, at 250 fpm. Ore fines belts are 36 in., 800 tphr and 340 fpm. Screened, sized ore belts are 36 in., 275 fpm and 625 tphr. Sinter belts are 36 in., 525 tphr. and 400 fpm. Miscellaneous material belts are 30 in., 380 tphr. and 230 fpm.

Bins for furnaces A, B and C will store 2500 tons of ore and 1333 tons of sinter; bins for D furnace, 1500 tons of ore and 500 tons of sinter.

Perhaps some of the differences between Weirton and Great Lakes plants are worth noting:

	Weirton	Great Lakes
Primary ore separation	Wobbler	Ty-rock scalping screens
Balling drum dimensions, ft diam × ft	12 × 40	12 × 50
Machine length, ft-in.	147	199-6
Grate area, sq ft	1764	2394
Wind Boxes	14	19
Pallet side boards, height, in.	18	20
Main fans, capacity, cfm	510,000	688,000
Main fans suction head, in. water column	35	40
Main fans motor, hp	5000	9000
Main fans, rpm	712	900
Cooler length, ft-in.	150	178-6
Cooler fans, capacity, cfm	504,000	616,000

Our operating time has been so brief we have not reached capacity and have no operating data to present. Some observations may be ventured.

No difficulties have been experienced because of the 12-ft machine and its design. With its divided wind boxes and goose necks on both sides, the machine runs straight, as reported on the earlier Inland machine.

Air and gas facilities to ignition furnace had to be increased for ignition of self-fluxing mix. Gas comsumption has been as high as 78,000 cfhr coke oven gas, and the requirement may be higher with fully self-fluxing sinter and faster operating rates.

Coke grinding in rod mills with moisture as high as 18 or 19 per cent has not been a problem. Coke feeding to mix and control in the mix has been and still is a problem. This has been the chief obstacle preventing higher operating rates.

Speed of pug mill and paddles has been reduced. Pug mill is operated about 8 rpm.

Balling drum is operated about 9 rpm. With its 50-ft length and drive gear mounted in the middle, the frame has been strengthened to reduce vibration.

Shear pins have been an item of trial and error. Final specifications probably have not been settled.

The small grate bar seems quite satisfactory.

The hearth layer has been very useful, especially with the unsatisfactory coke feed experienced at times.

The roll feeder, with rack-driven shuttle belt to surge bin above, has been satisfactory after the installation of a closed circuit television circuit to permit the operator to observe level. Machine speed control is manual. ▲

Thermit Welding Structural Mill Rolls

by Edward B. Russell, Assistant to Superintendent,
Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

The thermit weld, which theoretically has no size limit, cools once at a uniform rate throughout precluding formation of serious local internal stresses . . . . among its many steel mill uses are welding broken mill housing posts, press frames; rolling mill pinions; and crane rails . . . . thermit welding makes practical the cutting-off and reverse mounting of large one-direction mill pinions for extending the pinion's life.

SEEING a thermit weld "shot," as it is commonly expressed, is a spectacular and colorful sight, particularly after dark, the over-all appearance closely resembling that of a huge Fourth of July "flower pot."

Sixty to 65 years ago it was not quite so simple for at that time no practical solution to the problem of "touching off" this tremendous chemical reaction was known. At this early date scientists set off the reaction by preheating a cold mixture of metallic oxides and aluminum to a temperature just below that of melted cast iron. Igniting a preheated mixture at such a high preheat temperature produced highly explosive reactions which discouraged all practical uses of the mixtures at that time, except on an experimental basis.

Dr. Goldschmidt, a German scientist, discovered that by igniting a cold mixture of this type in one spot and permitting the reaction to permeate the entire mixture delayed this reaction sufficiently to reduce the explosive tendencies to reasonable time limits (30 to 40 sec). This made the process practical for safe industrial use in making thermit welds.

To apply this chemical reaction of "slow burning" to welding procedures, finely divided aluminum, because of its strong affinity for oxygen, was chosen as the reducing agent and mixed with iron oxide. So was born a new and important welding procedure patented in 1897 in Dr. Hans Goldschmidt's name. Soon after this the thermit welding process was introduced into our country.

Aluminum has a high affinity for oxygen, which makes it an ideal reducing agent. Table I lists the aluminum reduction of various oxides.

Figure 1 — This sketch shows the setup for thermit welding 29-in. structural mill rolls.

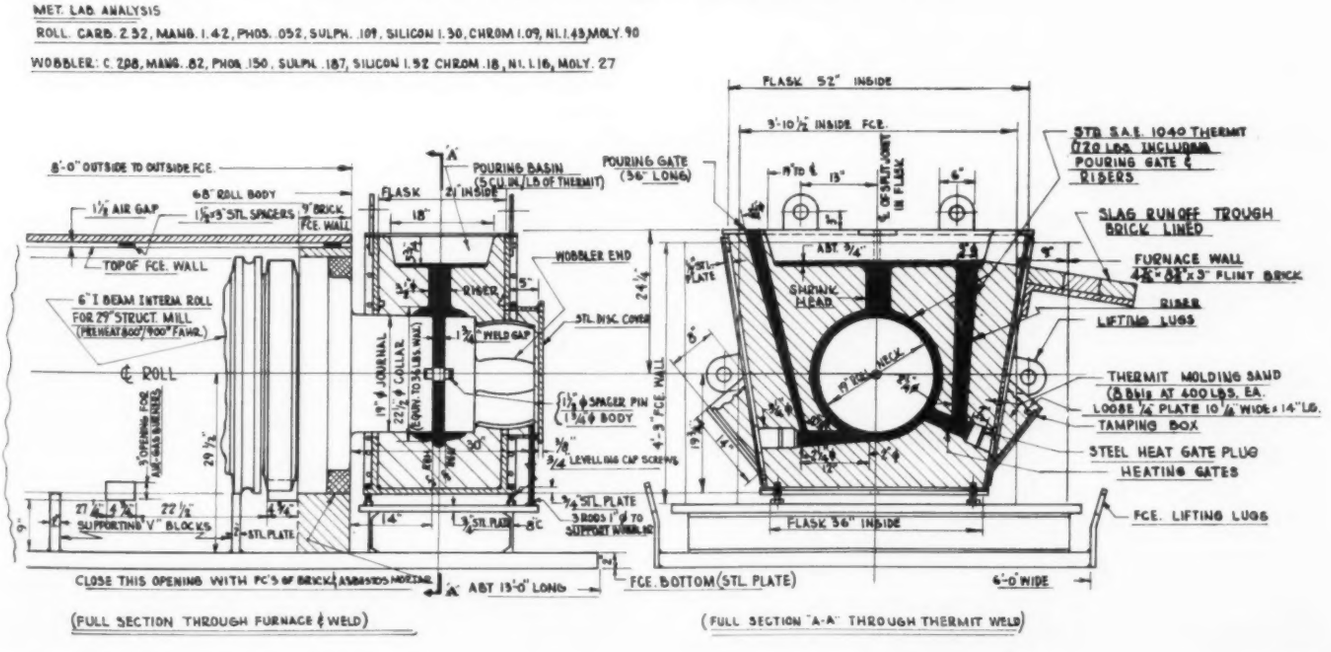

MET. LAB. ANALYSIS
ROLL. CARB. 2.52, MANG. 1.42, PHOS. .052, SULPH. .109, SILICON 1.30, CHROM 1.09, NI. 1.43, MOLY. 90
WOBBLER: C. 298, MANG. .82, PHOS .150, SULPH .187, SILICON 1.52 CHROM .18, NI. 1.16, MOLY. 27
FLASK 52" INSIDE
3'-10½" INSIDE FCE.
STR. S.A.E. 1040 THERMIT (720 LBS. INCLUDES POURING GATE & RISERS
8'-0" OUTSIDE TO OUTSIDE FCE.
POURING BASIN (5 CU. IN./LB. OF THERMIT)
POURING GATE (36" LONG)
FLASK
SLAG RUNOFF TROUGH BRICK LINED
1½" AIR GAP
68" ROLL BODY
1½"x3" STL. SPACERS
9" BRICK FCE. WALL
TOP OF FCE. WALL
WOBBLER END
FURNACE WALL 4½"x8½"x3" FLINT BRICK
RISER
6" I BEAM INTERM. ROLL FOR 29" STRUCT. MILL (PREHEAT 800°/900° FAHR.)
STL. DISC. COVER
SHRINK HEAD
LIFTING LUGS
℄ ROLL
WELD GAP
THERMIT MOLDING SAND (8 bbls AT 400 LBS. EA.
LOOSE ¼" PLATE 10" WIDE x 14" LG.
TAMPING BOX
SPACER PIN
STEEL HEAT GATE PLUG
HEATING GATES
LEVELLING CAP SCREWS
STL. PLATE
3 RODS 1" ℄ TO SUPPORT WOBBLER
SUPPORTING "V" BLOCKS
FCE. LIFTING LUGS
FLASK 36" INSIDE
CLOSE THIS OPENING WITH FC'S OF BRICK & ASBESTOS MORTAR
ABT 13'-0" LONG
FCE. BOTTOM (STL. PLATE)
6'-0" WIDE
(FULL SECTION THROUGH FURNACE & WELD)
(FULL SECTION "A-A" THROUGH THERMIT WELD)

TABLE I
Aluminum Reduction of Various Oxides

Metallic Oxides		Aluminum		Resistant Slag		Resistant Metal
3 Fe_3O_4	+	8 Al	=	4 Al_2O_3	+	9 Fe
Fe_2O_3	+	2 Al	=	Al_2O_3	+	2 Fe
3 Mn_3O_4	+	8 Al	=	4 Al_2O_3	+	9 Mn
Cr_2O_3	+	2 Al	=	Al_2O_3	+	2 Cr
WO_3	+	2 Al	=	Al_2O_3	+	W
3 V_2O_5	+	10 Al	=	5 Al_2O_3	+	6 V
3 TiO_2	+	4 Al	=	2 Al_2O_3	+	3 Ti
3 NiO	+	2 Al	=	Al_2O_3	+	3 Ni
MoO_3	+	2 Al	=	Al_2O_3	+	Mo
3 SiO_2	+	4 Al	=	2 Al_2O_3	+	3 Si
B_2O_3	+	2 Al	=	Al_2O_3	+	2 B
3 Co_3O_4	+	8 Al	=	4 Al_2O_3	+	9 Co

Thermit welding has many and varied uses in industry. Large mill pinions on one-direction drives can be cut off through the journal, and the driver end reversed to throw the gear tooth wear on the good side of the gear tooth. Broken mill housing posts, press entablatures and frames, rolling mill spindles, large crankshafts, stern frames on ships, railroad track and crane rails, are thermit welded. Large weldments and castings may be thermit welded together both as a matter of economy or to solve a shipping problem where railroad clearances cannot be met. Many types of mill rolls can also be welded, the structural mill roll being the particular type roll this paper deals with.

In designing large heavy units, plain forgings, small castings or weldments can be thermit welded into one unit often reducing the cost tremendously over what it would be should large intricate castings be used with their inherent problem of obtaining good sound metal in the casting. On some work no machining is required to make repairs. No machining is necessary on broken spindles, for example, when the weld collar is not in the way. Another important feature of a thermit weld is that stress relieving is not necessary, which is quite an item on large unwieldy castings.

Theoretically there is no limit to the size of a thermit weld because the metal is deposited in bulk and cools at a uniform rate throughout with only one shrinkage. Thus serious local internal stresses are not present in a correctly made thermit weld. Thermit welds are dense and sound because they solidify from the inside toward the outside. This is because the sections being welded act as enormous chills in the casting and extract heat more rapidly from the center than from any other point.

Excellent physical properties also result from the exclusion of air; the metal completely fills the mold thus prohibiting oxidation. Since the parent metal is not burned by localized overheating, no softening or alteration occurs during thermit welding.

The average percentage analysis of thermit steel consists of:

Carbon	0.05 to 0.10
Manganese	0.08 to 0.10
Silicon	0.09 to 0.20
Sulphur	0.03 to 0.04
Phosphorus	0.04 to 0.05
Aluminum	0.07 to 0.18

This gives an average tensile strength of about 61,000 and an average elastic limit of about 34,000 with physical properties closely approaching those of forged steel, even though a thermit weld is cast. The ductility ranges up to 25 per cent in 2 in.

Plain thermit is a mixture of finely divided aluminum and iron oxide, which is the basic mix for all thermit mixtures. As such, it is not used for welding, but can be used as a heating agent in this form.

Forging thermit is obtained by mixing plain thermit with additions of manganese and mild steel punchings. It is used in welding steel castings, forgings and heavy plates.

Cast-iron thermit is a mixture of plain thermit with additions of ferro-silicon, carbon and mild steel punchings and is, of course, used for welding cast iron.

Wobbler thermit is a mixture made up for producing a hard, wear resistant, machinable steel for building up worn wobbler ends of rolls and pinions.

Tables II and III list the approximate chemical analyses and physical properties of various types of thermit in current use. Other special mixes can be made up.

For those who are not familar with the thermit welding process, it may be well to briefly review the general procedures followed.

First the mating pieces requiring welding are alined with a predetermined gap between the ends for thermit metal. A wood platform is used in conjunction with a 2-part mold box to hold the molding sand rammed around the patterns. The molding material, a mixture of screened silica sand and clay is rammed around the patterns. The patterns are drawn and both halves of sand mold bolted to roll journal and wobbler previously setup with body enclosed in a loose brick furnace for preheat.

Kerosene-air burners, placed in heating gates provided in the mold box, are used to heat the roll end and wobbler end in the weld zone to a cherry red. After preheating, the heating gates are plugged, and a crucible filled with thermit is set over the mold box. A small amount of starting powder (barium peroxide) is placed

Figure 2 — This is the complete setup required for thermit welding the 29-in. structural mill roll. On the left can be seen a loose brick furnace, approximately 48-in. wide x 90-in. long x 55-in. high inside. On the side wall can be seen two small openings with air-gas burners. There are four, two per side, used for warming the roll body enclosed in the furnace to a pre-weld temperature of approximately 900 F. On the right, encased in a metal mold box, is the sand mold and wobbler being welded to a roll neck protruding from the furnace.

TABLE II
Approximate Chemical Analysis of Various Thermits, Per Cent

Type thermit	Carbon	Manganese	Silicon	Aluminum	Nickel	Chromium	Molybdenum	Sulphur	Phosphorus
Plain	0.15 max	0.15 max	0.60 max	0.10 max	...	...	...	0.04	0.04
Cast iron	0.10/0.20	0.10/0.15	1.30/1.40	0.05/0.35	...	...	...	0.02/0.04	0.02/0.04
Forging	0.20/0.26	0.55/0.85	0.35/0.55	0.05/0.40	...	...	...	0.02/0.04	0.02/0.04
SAE 1040	0.45	0.81	0.97	0.50/1.00	...	...	...	0.02/0.04	0.02/0.04
SAE 4340	0.34/0.45	0.50/0.80	...	...	1.50/2.00	0.50/0.80	0.30/0.40	0.05 max	0.04 max
Wobbler	0.90/1.00	2.90/3.75	0.60/1.00	1.50/2.00	...	...	...	0.02/0.04	0.02/0.04
Manganese steel	1.0/1.40	10.0/14.0	0.30/1.00	0.50/0.80	...	...	...	0.02/0.04	0.02/0.04

TABLE III
Approximate Tensile Properties

Type thermit	Yield point, psi	Ultimate strength, psi	Per cent elongation	Per cent reduction of area
Plain	22,650	44,775	35.2	52.3
Cast iron	32,166	50,875	19.76	52.3
Forging	34,722	65,611	23.0	20.1
SAE 1040	55,000	93,750	6.3	5.8
Wobbler	57,500	78,500	3.2	0.5

on the thermit and ignited with a red hot steel bar. This, in turn, sets off the thermit reaction at a temperature of 2800 F; and in 30 to 40 sec., regardless of quantity of thermit in the crucible, it becomes molten metal and slag. The slag being lighter floats on top of the metal. The crucible is tapped by lifting a metal pin in the bottom of the crucible. This permits the superheated metal to flow around the pin head and melt through it thus automatically tapping the ladle to allow the metal to pour into the weld. After the metal has solidified, the top of weld is banked with a blanket of sand, and the gas burners in the furnace are relighted to permit a slow cooling period. After cooling the mold box is stripped off, the gate and riser flame are cut off, and the roll is sent to the machine shop to have its roll recentered, and the weld collar is machined down to the journal diameter ready for use in the mill.

Roll breakage in any industry is a headache because a broken roll means expensive replacement.

Use of thermit welding makes it possible to salvage broken structural mill rolls that are not below scrap size. Considerable cost reduction may be obtained by standardizing the thermit welding procedure where possible by going to a pattern method of molding instead of the conventional wax method. Wax being very nearly equal in cost to thermit, pound for pound, adds materially to the cost of each weld, and after being melted out represents a total lose of labor and material.

Most structural mill rolls, fractured in the roll journal, follow very closely to a set pattern. In the weld under discussion the centerline of all welds are held to a standard distance of $12\frac{7}{8}$ in. from the thrust face on the broken end of the roll in question. All collars illustrated have the same outside diameter and width (9 in width $\times$ $22\frac{1}{2}$ in outside diam).

Further economy can be obtained by salvaging the good wobbler ends on rolls that must be scrapped because of having reached their scrap diameter. These salvaged wobblers can be used to replace broken ends lost in service on rolls worth salvaging by thermit welding.

A $1\frac{3}{4}$-in. gap is used for all types of structural mill rolls since the journal diameters are all alike, 19 in. diam. This makes it possible to use the same pattern for any type structural mill roll welded. All rolls, being of high carbon content, are parted to length in an engine lathe using carbide tipped cutoff tools. Where both ends of a roll have been broken off, lathe chuck jaws cannot be used to grip the broken journals. In this case the ends are milled off on a large horizontal boring mill.

Both the wobbler end and the roll end are drilled and reamed for a centering pin or dowel which establishes the gap with its shoulder length and holds the two parts concentric with one another.

Expansion and contraction in an axial direction have little effect on the positioning of the parts and are not of much importance because of the large clearances allowed between the end of wobblers and the coupling boxes driving them. It is important, however, to maintain parallelism between the faces of the weld joint to limit the wobbler runout to a minimum.

Proper preheating of the roll body, prior to welding, cannot be too strongly emphasized, a minimum of 40 hr and up to 72 hr being required with emphasis on a slow and uniform temperature rise of the roll to 900 F. The roll should be heated by hot air circulation, not by direct contact of flame with the roll body.

Considerable time can be saved by doing the preheating of the roll body during the time the mold is being rammed, which is another advantage of using the wood pattern method in place of the wax method.

A loose brick furnace laid up with asbestos mortar is sufficient and makes it easy to change the furnace for other jobs in the interim of time between thermit welds. A plain flat steel plate is all that is required for a roof or lid on the furnace. Two burner openings are placed in each side of the furnace for preheating gas-air burners. This allows shifting the burners from the back to the front a couple of hours prior to pouring to increase the temperature of roll body adjacent to the weld thus obtaining a more uniform temperature gradient in the roll body core when the shock of the extremely high

Figure 3 — A sand mold is about to be made with this pattern setup which provides venting, cavities, etc.

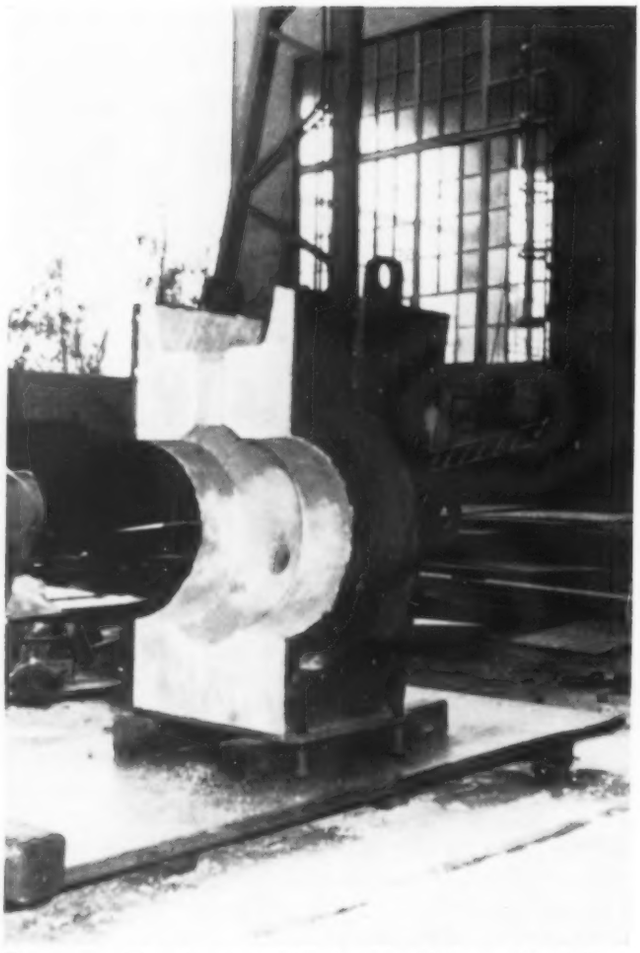


Figure 4 — This is an excellent view of the cavities left in the mold by the removal of the patterns. Any patch work required, such as broken corners or damaged edges and rounding-off of sharp corners in gates, risers and pouring gate, is completed at this time; and then the mold is carefully picked up again with the crane. Notice how the collar is tapered on each side down to the weld journal. Tapering the collar to a feather edge prevents the molten metal from undercutting the roll journal.

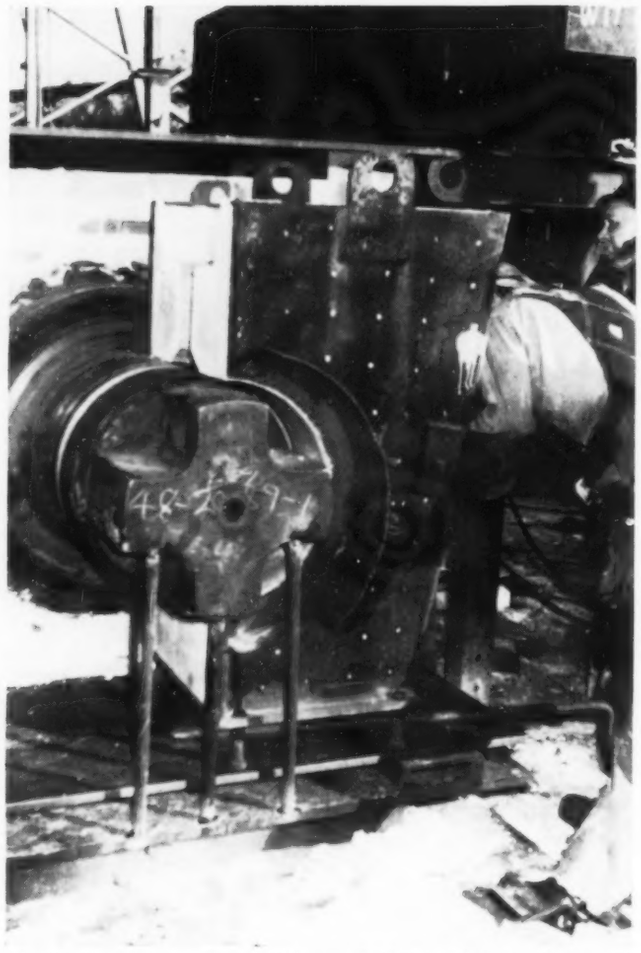


Figure 5 — Shown here is the mold box which has been set down on the flat plate. By making simple adjustments of the four cap screws supporting the box it can be slid carefully into place, tight against the outside diameter of the roll and wobbler journals. This must be done carefully to insure a good fit between the mold sand and the journal outside diameter. Also the centerline of the collar in the mold must true up closely with the centerline of the weld gap on the roll neck in order to maintain suitable clearance from the end of the furnace to the mold box so that space is available for luteing at a later stage in the process.

temperature rise at the time of pouring flows through the roll. High temperature differentials adjacent to one another in a roll cross-sectional area can create very high stresses in the roll with disastrous results.

Where thermit welds are infrequently made, salvaging of the molding material and reusing it is not of much advantage, and in this case it is better to forget about reusing the sand, the cost involved in handling, screening and tempering being prohibitive. However, in designing flasks for infrequent welds, large quantities of thermit welding material can be saved by keeping minimum clearances in the mold box. This is why the mold box in the illustrations is tapered severely. The mold box illustrated contains 1½ tons of molding material at the completion of the mold.

Alinement, flask-to-molding-board and flask-to-flask, must be maintained at close limits to insure assembly when mold halves are completed. All flasks should be built rigid so that ramming pressures and handling of molds will not crack the molds. It is very important that a good refractory molding material be used, or trouble may be experienced from the mold breaking or melting down during the preheating cycle of the pour.

Two-parts silica sand, one-part fire clay thoroughly mixed when dry and then screened through a 4-mesh riddle should be moistened just enough to adhere well. Sands and clays vary greatly in binding and refractory qualities, and only the best should be used.

If too wet in preheating, the gates will close in, and the mold will spall badly and result in very rough weld collars.

In the mixing of thermit molding material, the water content should be about 12 per cent by volume or about 8 per cent by weight. This proportion will give about the right "temper" for ramming. If a handful of prepared sand is squeezed in the hand and leaves wetness in the palm of the hand, too much moisture is present. Conversely speaking, if the wad of sand will not support its own weight, then it is too dry. In venting the sand mold, after ramming, for the escape of gases and steam, care should be taken not to vent closer than 1¾ to 2 in. to the mold cavities using 8 to 10-gage wire.

In ramming a mold of used sand, it is best to use new molding material adjacent to the pattern until a

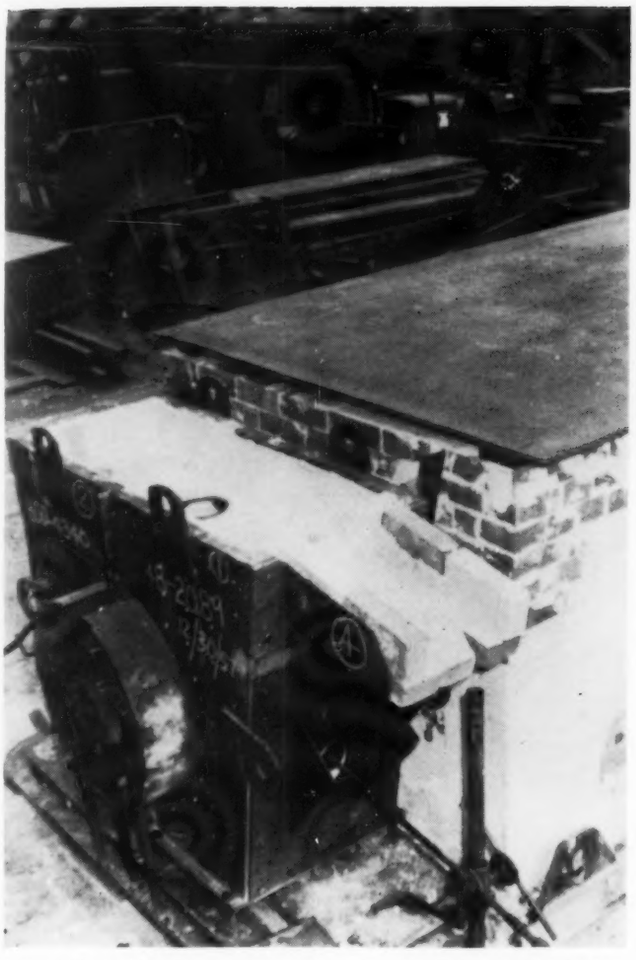


Figure 6 — Shown is a completed mold setup ready to begin a preheat. The two mold boxes have been bolted securely together; and on the right mold box, a slag runoff trough lined with brick and sand has been mounted with its drain-off level about 1¾ in. above the bottom of the slag basin, leaving only about ¾ in. for extra metal and 1 in. for slag, the remainder of the slag being run off into a large brick-lined box on the right at the time of the pouring.

layer of not less than 2 in. thick is obtained before using old molding material.

Occasionally it is necessary to hold a mold a short time before starting to preheat. A finished mold should not be held more than two days because the sand disintegrates and is apt to fall out. (The bonding material loses its strength).

Before ramming a mold the patterns are always dusted with a parting dust to keep sand from adhering to the pattern at the time the pattern is drawn.

While there do exist certain hazards peculiar to thermit welding, still it is actually no more dangerous than any other similar job providing certain precautionary measures are taken.

SAFETY

Precautionary measures should be taken as follows:

1. Careful drying out of the crucible just prior to charging it with thermit will insure that no moisture is present. Make certain crucible is securely mounted since it will be top heavy. The crucible after the drying out period should be cooled below 2500 F before charging it with thermit.

2. Thermit should be stored in a cool, dry building free from moisture or dampness and should be covered in the event a leak occurs in the roof.

3. Ignition powder, being highly inflammable, should never be stored adjacent to thermit or left with its lid off.

4. Bolts should never be omitted here and there in the mold box joint flanges for tremendous pressure is exerted on these bolts due to the expansion of the sand during preheating and the pour.

5. Back ramming or luteing, as it is termed, is a disagreeable job because of the heat present while it is being done. It should, nevertheless be done just prior to pouring and not prior to preheating, this to insure sealing of any cracks occuring in the mold during the preheating stage. In the case of the roll wobblers discussed, it is advantageous to have the end of the wobbler exposed as an aid in determining when it has reached welding temperature.

6. Of course it goes without saying that all loose material, tools and particularly oxygen, gas and air lines should be cleared away from the weld site for a radius of at least 25 ft; not only as a tripping hazard, but also as fire protection in case of a runout of hot metal or a spill-over of hot slag which could well burn through a hose and should the hose be pressurized it would be very dangerous. Eye and face protection are essential. One can well visualize the damage one hot grain of sand blasted from a mold vent could do to an eye.

7. "Shooting" a thermit weld attracts onlookers. So, shooting welds at or near a shift change should be avoided, if possible.

8. Taking your crew into a "huddle" just prior to preparations for pouring is a good thing to do regularly. Make sure your men know of a certainty who will light the thermit, who will do the tapping, who will decide when to light and when to tap, and who will give the crane signals.

9. Keeping a standby overhead crane all rigged up for lifting crucible and stand is good insurance in case something should go wrong.

10. On every pour be sure you have an experienced craneman in the crane. If he is a new man, make certain he can keep his head if something goes wrong and also explain to him the magnitude of a thermit reaction

Figure 7 — The tapping mechanism is made up as a toggle mechanism to give a vertical lift.

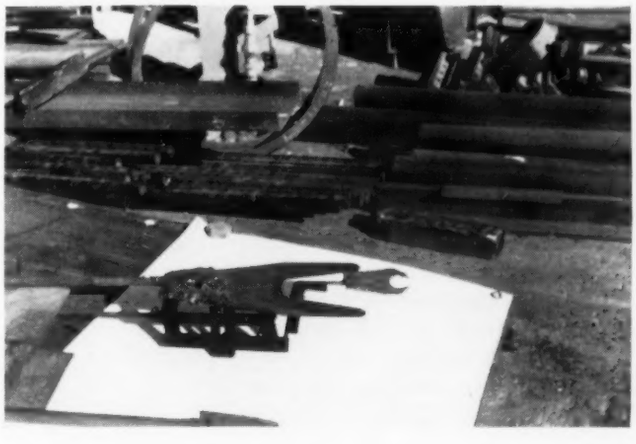


Figure 8 — Pouring of 750 lb of thermit.

Figure 9 — The weld has been made, the mold stripped off, and the roll body has cooled to 300 F.

so he is not suddenly surprised and panicked at the sight of the reaction. Other cranes in the area should be cautioned against crossing over the mold during pouring operations or at any time with a large part dripping water from rain or a steam cleaning job.

11. For the man doing the lighting and tapping, a $^3/_4$-length wool coat, safety shoes, face hood, dark goggles, asbestos neck shroud and asbestos gloves should be provided. Care should be taken not to encumber the man more than necessary for he has only about 30 seconds from the time he "touches off" the reaction until he taps the pour.

12. An extra tapping spade should be available as well as dry sand for covering slag spillage where required.

Numerous other precautions could be mentioned, but the author assumes that it is understood that standard safety precautions applying to any mill job will, of course, be observed.

APPENDIX

Data Sheet On roll Illustrated

10-in. channel finishing roll (Steel)
Approximate analysis: 2.11 carbon, 0.50 maganese, 0.040 phosphorous, 0.048 sulphur, 0.61 silicon, 1.03 chromium —0.70 nickel, 0.35 molybdenum
Journal diam, 19 in.
Weld gap, $1^3/_4$ in.
Weld collar outside diam. $22^1/_2$ in.
Weld collar width, 9 in.
Thrust face of roll to centerline of journal, 12 in.
Materials required for weld proper:
- 800-lb SAE 4340 thermit.
- one package size No. 3 plugging material.
- one No. 4 firing pin.
- one no. 4 crucible thimble (for size no. 12 crucible).
- 35 Sacks molding material (at 100 lb per sack = 3500 lb.)
- one can igniting powder (barium peroxide $^1/_2$ teaspoon per weld).
- one 55-gal drum kerosene oil for preheating (2 burners used).

Data

Three 6 lb of iron scale to one lb of aluminum react according to the chemical formula: $8\ Al + 3\ Fe_3O_4 = 9\ Fe + 4\ Al_2O_3$
Expressed in weights:
Three 6 parts of aluminum 10 parts of iron oxide will produce seven parts steel.
The steel produced represents about one-half of the original quantity of thermit by weight and one-third by volume.
Temperature hot metal (computed)—4881 F. (Approximately twice as hot as ordinary molten steel.)
Reaction is nonexplosive and relatively slow, requiring about 30 to 45 sec.
To ignite thermit requires a temperature of 2800 F. (Barium peroxide is used—highly inflammable.)

Gap = $\sqrt[3]{\frac{\text{Area}}{3.6}}$ Width of collar = $\sqrt[3]{\frac{\text{Area}}{10}}$ + twice the gap

100-lb forging thermit = approximately 200 cu in. of steel.

Basic thermit reaction: $8\ Al + 3Fe_3O_4 = 9\ Fe + 4\ Al_2O_3$

Al + iron oxide = Thermit steel and aluminum slag.

On crane rails—each lb of wax used requires 15 lb of thermit.

LH70 Weld Rod used to tack pipe supports to wobbler.

Discussion

PRESENTED BY

R. E. SHAFFER, Superintendent Roll Shop, Saucon Div., Bethlehem Steel Co., Bethlehem, Pa.

EDWARD B. RUSSELL, Assistant to Superintendent, Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

WILLIAM MILLER, Assistant Superintendent, Shops, Tennessee Coal & Iron Div., United States Steel Corp., Fairfield, Ala.

H. E. MULLER, Superintendent Roll Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

EARL BENEDICT, Roll Shop Superintendent, South Works, United States Steel Corp., Chicago, Ill.

R. E. Shaffer: When Mr. Russell says roll breakage in any industry is a headache because a broken roll means replacement which is expensive, he is indeed expressing well the thoughts of all concerned with a rolling mill. In an economic period such as we are presently experiencing, we are all probably more cost conscious than we may be during a period of high productivity.

I have several questions I would like to ask Mr. Russell. We have had a bit of experience with thermit welding, having welded the journals on four 48 in. universal mill rolls for B 36 wide-flange section. These rolls had broken wobblers. The results have been entirely successful as the rolls were used to their minimum size on the 48 in. mill and then recut for use on a 42-in. universal mill. No machining difficulties were encountered.

1. Mr. Russell, could you give us a comparative cost, percentage wise, of thermit welding a 28 in. structural mill journal to another wobbler, compared to the cost of a new roll, at current prices?

2. Also in the line of cost, how does wobbler thermit mixture compare to that of building-up a wobbler by manual electric welding?

3. Do you think it practical to weld a roll which has been broken through the body?

4. Is there any direct relation between pin dimensions and the diameter of the journal to be welded?

5. You state that thermit welds are dense and sound because they solidify from inside toward the outside. Have attempts been made to substantiate this or is it a theoretical explanation of solidification?

6. In thermit welding of cast iron, is any difficulty encountered with hard spots at fusion line, in machining or in service?

Edward B. Russell: Thermit welded rolls will vary considerably in costs depending on their size and the number of packs involved. We have found that generally a thermit weld costs about a third the cost of a new roll. Where half of the life of the roll is left we consider the weld worthwhile.

On rolls where it is possible to weld manually with an electric arc it is much cheaper naturally to weld with electric arc. We have successfully welded rolls of as high as 1.48 per cent carbon. We have tried others higher than that but have had bad luck with them. You can weld a roll with a submerged arc machine. As far as electric arc welding goes, you can weld a roll overnight with no comparison between that and thermit welding if the material analysis is right.

On welding a roll through the body, that depends first of all, whether the body has an outside hard surface on it or not. I would not attempt to weld a roll that did have a hard outside surface. Usually welding a roll through the body would be a single weld job; it is not a recurring weld, and would not recur often enough that you would be tooled up for it. I do not believe it would be an economical thermit weld.

On pin dimensions, there is no direct relation except from a machining standpoint. There are then two things that enter into the picture. If the pin is too small in diameter the wobbler will have a tendency to sag. Also, if you use a ¾-in. pin instead of 1½ in. as I used, the ¾-in. pin would be much more difficult to ream and hold to full tolerance. You would be apt to get a loose fit which would allow your wobbler to sag. We make our pins a light drive fit. We ream the holes in the roll and the wobbler first. The hole is reamed to exactly the right size. Then we turn the pins to fit each hole and have each one measured individually to make it a light drive fit.

On how the weld cools. I would say that I have used a theoretical explanation. However, by looking back on my practical experience, I will say this: Oftentimes when you refill your kerosene burners you have to shut your preheater burners off to change or add kerosene. Sometimes when you shut your burners off just prior to a pour, if you will watch the ends of the two pods when they are heated red hot, you will see that they will start to draw back and turn black if they have not as yet been heated hot enough. They generally turn black in the center first, showing that the roll is drawing its heat from the center of the roll first. Another point from my practical experience that would help answer that question is that, when we preheat the roll body, we are heating the outside of the roll. Naturally the center of the roll is not going to be as warm as the outside unless you use an extremely long preheat. Now, under production procedure, it is very tempting to push a thermit weld and try to get it done by a certain time. I think oftentimes thermit weld failures occur for that reason.

On the last question, I presume Mr. Shaffer refers to the collar fusion point on the neck of the journal diameter. Usually if you leave the mold in the sand long enough during the cooling period, there is enough heat in the weld to draw the temper down to a point of machinability.

William Miller: What are the advantages or disadvantages of thermit welding wobbler ends over arc welding?

Edward B. Russell: We have been unsuccessful in arc welding several of them because they ran much over 2.0 per cent carbon.

William Miller: We are interested in the service life of the welded roll.

Edward B. Russell: We have been very lucky, we have not lost any rolls that we thermit welded. In fact, I think anybody that does thermit welding will tell you the same thing. You very seldom break a thermit weld. Sometimes you have a break due to improper heating or in another section of the roll on whatever you are welding. But very seldom do you ever break a thermit weld.

William Miller: To what extent have you had experience in thermit welding work rolls used in cold mills and hot mills and so forth?

Edward B. Russell: I have never welded cold mill work rolls.

William Miller: I would like to ask whether you would recommend thermit welding of cast iron rolls over the Palmer method using the oxygen acetylene torch method of heating with cast iron rods and the puddling method? We have used this method on quite a large number of work rolls in the past. What has been your experience with this method?

Edward B. Russell: I have not used that method on journal welds. I would be afraid of it from the breaking standpoint. At our particular mill it is due to the fact that we break most of our rolls through the journal while most others break the wobblers off or chip the corners off the wobblers.

William Miller: What, if any, trouble is encountered when the weld collar is machined off to the roll neck diameter and particularly at the portion where the welded metal joins the base of the parent metal? Do you have a small recess there that leaves a mark in the roll neck diameter?

Edward B. Russell: Yes, we do on quite a few of our rolls. However, we are using phenolic bearings and it does not matter too much.

We grind the weld collar down to the existing journal diameters, whatever they may be, oftentimes it is a shade under 19 in. I have also noticed that, if we are in too much of a hurry to remove the roll from the sand, the surface is very hard and difficult to machine. You might also be interested in knowing that we burn the riser and gate off flush with the weld collar. If you leave a half inch or more protruding beyond the diameter of the weld collar, that projection will produce an interrupted cut every time it comes around in the lathe and will break cutting tools. When it is burned off flush, you can sink the first cut deep enough to get below the hard surface with the point of your cutting tool.

William Miller: What experience have you had in thermit welding larger rolls such as slab or blooming mill rolls?

Edward B. Russell: On thermit welding rolls my experience has been limited to structural mill rolls.

William Miller: We have attempted it on two different occasions. I think one was partially successful, the other was not quite so successful.

Edward B. Russell: I have thermit welded quite a few pinions; and if your break is through the wobbler end on the neck of the roll, I believe it can be done. You have to be very particular in your preheating. A long preheat is necessary. We found it out the hard way.

William Miller: We have found that welding the ends on the pinions is much more economical to arc weld them than to thermit weld them. We have had good success on arc welding the larger pinions.

What gives the better work qualities or properties, wobbler thermit or manganese thermit in welding up the wobbler? Also, in the investigation of the chemistry used in this material, what condition do you get from the cracking or spalling effect from the repeated impact that it is subjected to?

Edward B. Russell: I have not had any trouble with spalling. I would think that the manganese would have much higher wear quality.

William Miller: Can you arc weld or build up the wobbler after it has been thermit welded?

Edward B. Russell: Yes, we do. There are usually a few pin holes or spots on the side of the *Riser* on the *weld collars*, as we weld up and machine.

William Miller: Can it be machined afterwards?

Edward B. Russell: It can be machined afterwards?

H. E. Muller: We employ both the thermit and submerged arc method for repairing rolls. I have been prompted to ask a few questions with the help of our weld shop people. Are all your rolls, spindles, etc., thermit welded or do you submerge arc some of them?

Edward B. Russell: We submerge arc weld a number of them. Generally, our rule of thumb is that on any roll below 1.85 carbon and not too high in chrome, we use a submerged arc weld. Anything above that we weld with thermit.

H. E. Muller: When welding cast iron to steel why do you use cast iron thermit? Why not forging thermit? It has been found in our practice that forging thermit in such an application produces a sound weld whereas cast iron has a tendency to be porous.

Edward B. Russell: In welding steel to iron you can use either thermit. There is very little difference in the two thermits. It is mostly nomenclature more than anything else. However, in general, if you are welding cast iron to cast iron, you better stick to cast iron thermit.

H. E. Muller: Do you find shrinkage at the edges of the collar at the weld? If so, how do you correct this?

We usually undercut this area approximately ¼ in. and then apply semi-hard surfacing metal by the submerged arc process.

Edward B. Russell: We leave it as cast. It does burn under a little bit which is of no consequence since it does not give us any problem in our experience. We have not had any trouble with it so we do not bother with it. It could be welded up, however. I will say that. We do not bother turning and welding it because we do not require it.

H. E. Muller: Are you in a position to quote a figure on the average cost of repair, per roll neck, by the thermit weld process?

Edward B. Russell: I believe I have answered that unless you have further questions on it. One-third of the original cost of the roll is required for a thermit weld. When not less than one-half the roll life is left, we consider a thermit weld economical.

H. E. Muller: Have you tried using a fuse for igniting thermit ignition powder? If so, do you recommend its use?

Edward B. Russell: I have thought of that. It is not a new thought, and I believe it would be possible.

But it is a very risky thing. You would still have to use your barium peroxide, because, it takes 2800 F to ignite thermit. You could not get that temperature with a fuse so you would still have to depend on the fuse to ignite your barium peroxide powder. Now, if you put a fuse up there, light it, nothing happens, you think the fuse is dead, and a man goes up on the platform about 15 ft and peers over the top to see whether the fuse is dead or not. Should it happen to react, he would get a terrific burn and he might fall 10 or 15 ft to the ground. From the safety standpoint alone I would turn it down.

H. E. Muller: In back ramming or luteing, do you find it a problem to pack the dry sand? Earlier you mentioned the necessity of moist consistency for good ramming purposes.

Edward B. Russell: I believe there was a misunderstanding. We do not use dry sand for back ramming. Regular tempered mold sand is used which has moisture in it. We wait until the parts are almost up to the heat prior to welding temperature, and then we ram this moist sand around the hot parts to seal off any thermit metal that might escape from the mold due to cracks, looseness or what have you.

Earl Benedict: Had I been up here first I would have had questions to ask, but most of them have been answered.

We have thermit welded structural mill rolls for 15 or 20 years and have yet to experience a failure in a thermit welded roll either in the thermit weld or any place else in the roll. We use a forging thermit in our roll welding and have not used any other type of thermit.

One question I do have. We have a mill where we twist off or break one of the four pods on a wobbler. We have attempted to weld these up with arc welding, but whenever we do weld them up the roll usually fails due to that one breaking off and taking off some more. I would like to ask if welding up just one pod on a wobbler has been tried and if that has been successful?

Edward B. Russell: You mean welding by thermit weld or arc weld?

Earl Benedict: By thermit weld.

Edward B. Russell: I do not thermit weld any pods, but it is possible. There are people who do it regularly and they generally do it in a vertical position, which gives you better chance to heat it. ▲

Available Translations

As a service to readers of the Iron and Steel Engineer a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to one of the preceding sources.

913 Eisenkolb, F.: "Production and Properties of Sintered Stainless Steel," *Stahl u. Eisen*, 1958, Feb. 6, pp. 141–148. (Abstract J.I.S.I., 1958 Sept. p. 92A: The author reviews present production methods for corrosion-resistant sintered steel and discusses methods for the production of powder from austenitic steels. High-chromium steels are difficult to sinter, the sintered parts show high porosity and low strength. The use of liquid-phase sintering by addition of boron and phosphorus overcomes these difficulties. Addition of nickel to steel powder increases the strength and reduces the porosity of sintered parts. Corrosion-resistance is greatly impaired by the porosity of the sintered compacts.)

942 Danielou, G.: "Electrical Equipment (for Arc Furnaces)," *L'Acierie Electrique*, 1957 (Cahiers du Cessid) No. 1, Part 2, pp. 1–29. (Abstract J.I.S.I., 1958, Oct., p. 213c: The fundamental factors affecting the consumption of electric power in arc furnaces are first considered; these include stability and reactance. High voltage and low voltage equipment is reviewed. Commercial systems of arc furnace control are described. Induction stirring of liquid steel is briefly mentioned.)

1073 Czikel, J.: "The Fundamentals of Pouring Technique," *Giesserei-Nachrichten*, 1956, Dec. pp. 5–14.

1132 Zinov'ev, N. V.: "Modern Hot-blast Cupolas for Steel-melting Plant," *Stal*, 1958, Sept., pp. 796–799.

1162 Efroimovich, Yu. E., et al.: "A Computer for Controlling the Parameters of an Arc Furnace," *Elektrichestvo*, 1958 (5), pp. 15–20.

1168 Adabaschjan, A. K.: "Measuring Roof Temperature in the Open-hearth Furnace by means of a Photo-electric Pyrometer," (abridged) *Neue Hutte*, 1958, Oct., pp. 615–619.

1173 Berdyansky, M. G.: "The Mechanisation and Automation of Tube Production," *Stal*, 1958, Oct., pp. 928–930.

1180 Guthmann, K.: "The Problem of Clean Air, with Special Reference to the Iron and Steel Industry" III—The Removal of Dust from Flue Gases of Arc Furnaces. *Radex Rundschau*, 1958, Nov. (7), pp. 323–347.

1187 Antoni, H.: "Accidents in the German Iron and Steel Industry in 1957 (Works Accident Statistics) with Comparative Data from the American, British, Japanese, French, and Austrian Iron and Steel Industries," *Stahl u. Eisen*, 1958, Dec. 25, pp. 1891–1898.

1189 Gueussier, A., and R. Castro: "Experimental Study of Hot Deformation of Steels and Alloys," (with discussion and bibliography), *Rev. Met.*, 1958, Nov., pp. 1023–1041.

1190 Mathea, A.: "Nomograms for the Determination of Roll Force, Based on the Equation of S. Ekelund," *Stahl u. Eisen*, 1958, Oct. 2, pp. 1383–1389.

Latrobe Steel Co. Starts Consumable Electrode Vacuum Arc Furnace

LATROBE Steel Co., Latrobe, Pa., is operating a new consumable electrode vacuum arc melting furnace. The furnace and its components were designed and built by Lectromelt Division of McGraw-Edison Co. in co-operation with Latrobe's technical and engineering personnel, and is considered to represent a major advancement in the field.

The furnace is a 20-in. diam unit capable of producing a maximum ingot of 8500 lb or an annual output of 3000 net tons. It uses a compact power source consisting of a 17,500-amp silicon diode rectifier sealed in a water-cooled housing and controlled by a saturable reactor. Individual current and voltage control permits close regulation of the melting operation to the desired conditions. The unique, sensitive electrode control system is completely automatic and eliminates the need for visual observation.

The electrode suspension mechanism provides positive drive up and down, giving sensitive, low speed automatic regulation during melting and high speed for manual operation between melts.

The furnace is equipped with a mechanical booster type vacuum system of 4500-cfm capacity with a blank-off pressure of under five microns.

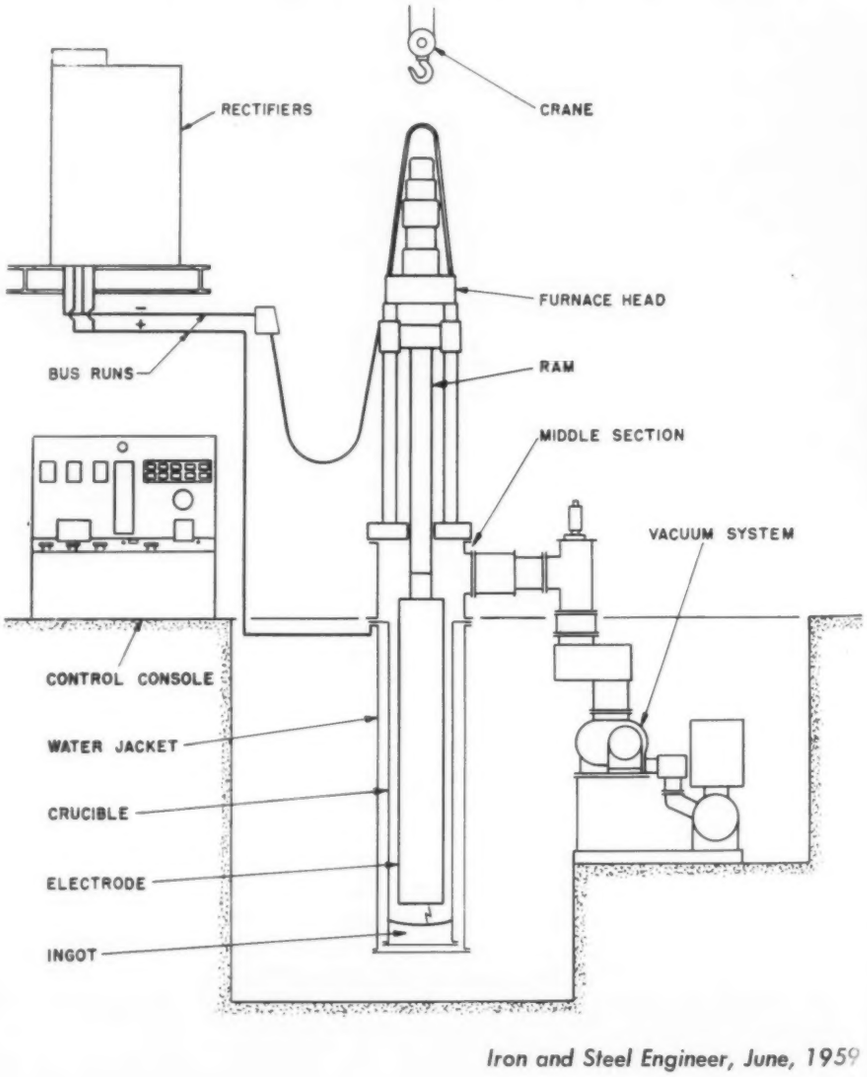
In the process, a cast electrode of the desired alloy, made by conventional steelmaking methods, is suspended in the water-cooled copper crucible. A low-voltage, low-amperage arc is struck, amperage is increased and the electrode melts. Some inclusions are removed by reaction in the arc, and dissolved gases in the steel are drawn off under vacuum. As the molten alloy in the crucible continuously solidifies from bottom to top, other non-metallic inclusions float to the top and segregate in the top few inches of the ingot. Segregation of constituents from surface to center is virtually eliminated. The result is an ingot with exceptionally sound internal structure.

Low alloy steels and bearing steels from this process show improvements up to 30 per cent in fatigue strength and up to 100 per cent in transverse ductility. In the market, this quality earns a premium price.

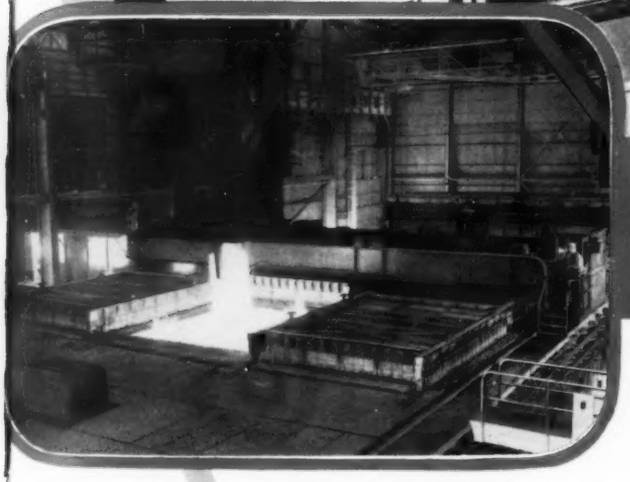
The furnace melts at rates of 1000 to 1600 lb per hr. The maximum ingot (20-in. diam x 17 ft-6 in. long, 8500 lb) of alloy steel is produced in about 5 hr. D-c voltage ranges between 20 and 40, and current is about 11,000 amp. Arc length is maintained at $\frac{3}{4}$ in. to 1 in. Vacuum ranges from 12 to 20 microns during melting. Power consumption runs 400 to 450 kwhr per ton of product. About 20 minutes downtime between ingots is sufficient to remove and strip the ingot, insert the mold and start operation on the next ingot.

The building housing the furnace is adequate to accommodate two more units. ▲

Figure 1 — Schematic diagram shows related physical and operating components of the new consumable electrode vacuum arc melting furnace.



Automatically Controlled Soaking Pits



Ingot drawing at a Rust recuperative soaking pit at Lorain Works

NINE-HOLE SOAKING PITS designed and constructed for National Tube Division, U. S. Steel Corporation, Lorain, Ohio.

The two-way, top-fired, recuperative soaking pits feature completely automatic temperature, fuel air ratio and furnace pressure control. Three batteries of three holes each; hole size: 12′ 6″ wide, 15′ long and 15′ deep. Constructed for Lorain Works, these soaking pits were designed to utilize Rust tile recuperators, which pre-heat air for combustion to 1300°F., resulting in increased efficiency and fuel economy.

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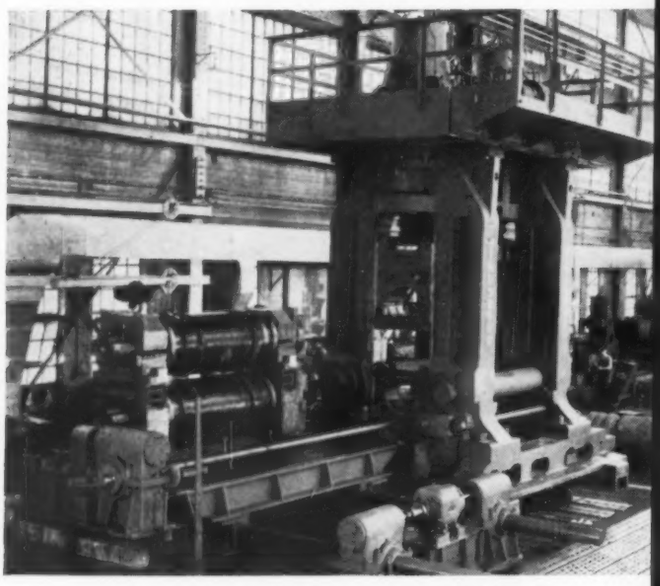
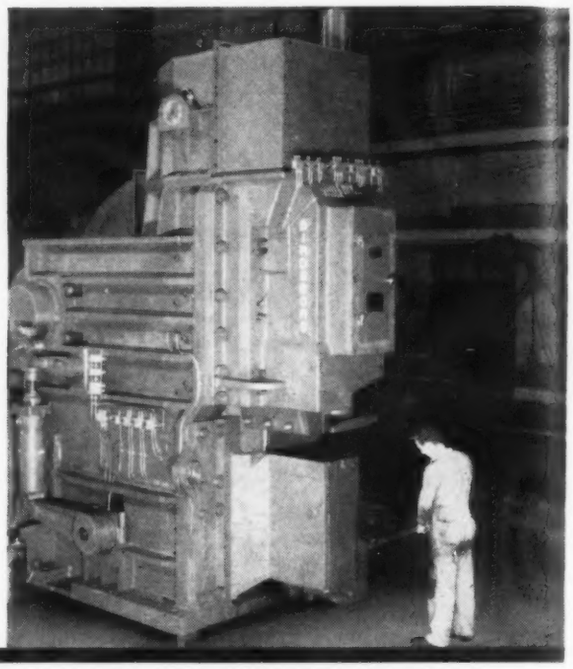


Blooming Mills by BIRDSBORO



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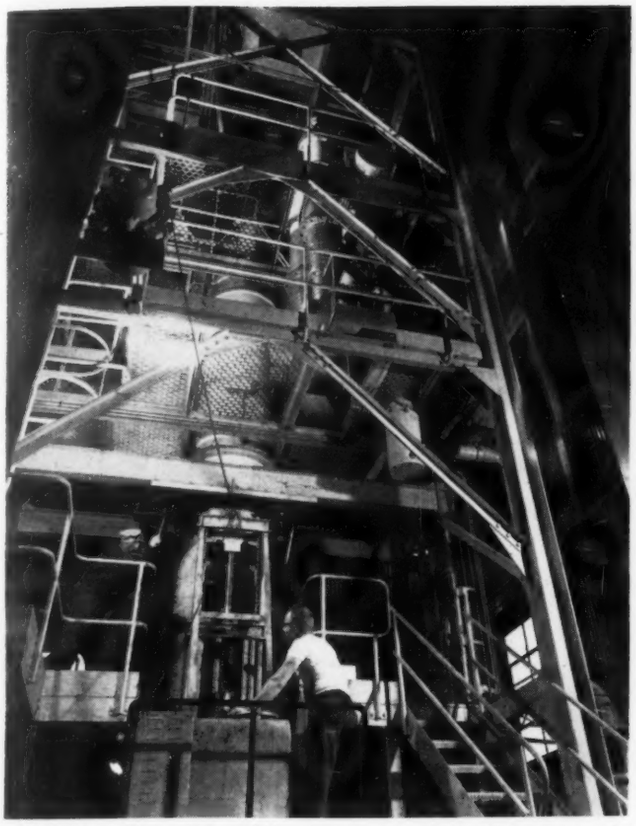


Figure 1 — Vanadium-Alloys' new consumable electrode vacuum melting furnace will produce ingots from 9 to 24 in. in diameter.

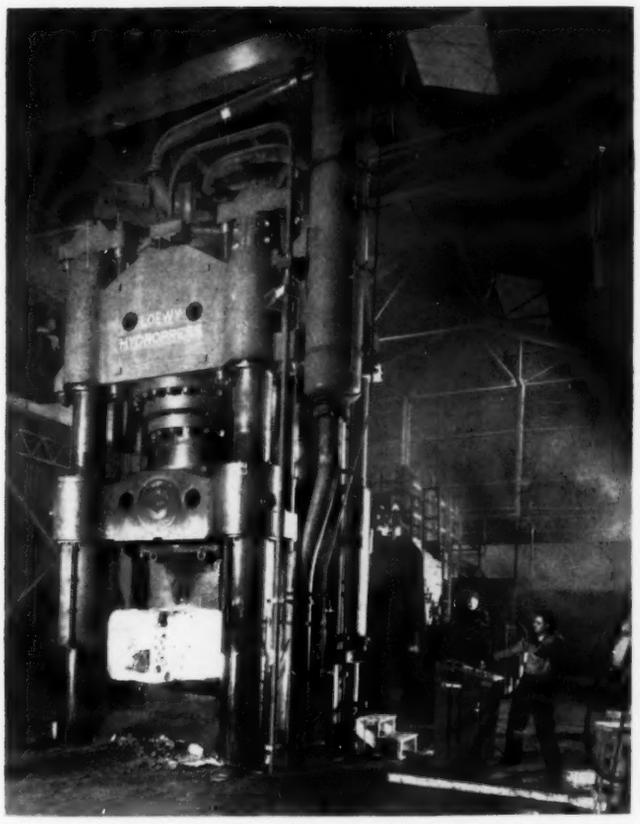


Figure 2 — New press in operation at Colonial Steel Co. Div. in Monaca is rated 2000 tons.

Vanadium-Alloys Steel Co. Completes Expansion Program

ACOMPLETION of a balanced plant expansion program costing more than $3,500,000 was announced recently by Vanadium-Alloys Steel Co., Latrobe, Pa. The 49-year-old company, a leading producer of tool and special steels, has made significant new additions to its capacity for fine steel production, finishing and delivery. Principal items in the expansion program include a new vacuum melting furnace especially designed to meet Vanadium-Alloys' specifications, new rolling mills and a continuous controlled atmosphere annealing furnace at the Latrobe plant, and the installation of a 2000-ton vertical hydraulic forging press at the firm's Colonial Steel Co. Division in Monaca, Pa. In addition to these major equipment items, all required auxiliary heating and handling equipment has been installed together with additional test and inspection facilities reflecting new advances and the latest techniques in fine steelmaking. New buildings totaling 97,000 sq ft in area have been erected at the two mills to contain the expanded operation.

Vanadium-Alloys stressed that the basic advantages of the new integrated installations lies in the ability to produce finer steels than ever before possible and faster.

VACUUM ARC MELTING FURNACE

Housed in a building of its own at Latrobe is a 45-ft high, consumable electrode vacuum melting furnace.

Design features—The design of the furnace incorporates many important features. Two unique features can best be seen in the control room. One of these is in the controls themselves, where the activation of one button starts the automatic sequence starting and self-acting operation of the vacuum melting process. In other words, by pressing a single button, the vacuum melting process begins, with electronic controls automatically turning on and off the various vacuum pumps. The same electronic system operates the opening and closing of valves and electronically adjusts the melting arc itself. Another major convenience and safety feature of the Vanadium-Alloys furnace can also best be seen in the control room. This is

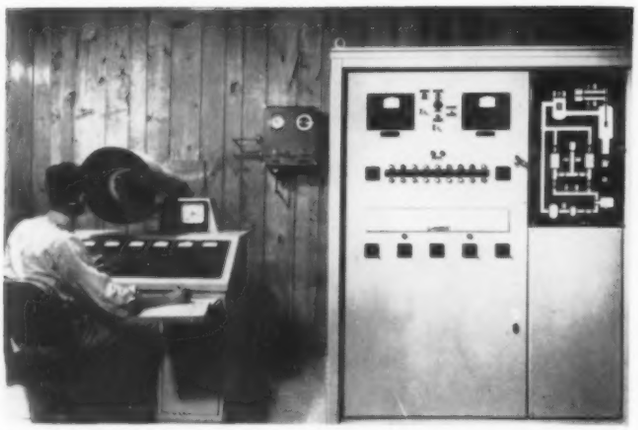


Figure 3 — Control room features advanced electronic control of new vacuum melting furnace.

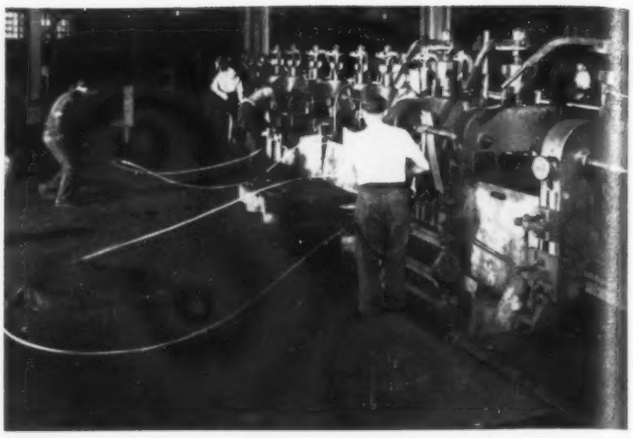


Figure 4 — Vanadium-Alloys' new 10 and 12-in. rolling mills process billets into rounds from ¼ to 1⅛ in.

the remote optical viewing system which gives the furnace operator a continuous visual view (somewhat similar to television) of the arc and the molten pool.

A high-capacity vacuum pumping system keeps pressure levels below five microns or 0.00000658 atmosphere. An automatic electronic arc control system provides for the holding of a very short, consistent arc length, which materially aids in maintaining a shallow molten pool so necessary for homogeneous ingot build-up and flotation of inclusions with more efficient degassification.

Final quality of vacuum consumable arc melted mill products is influenced by electrode preparation and conversion as well as the actual melting process.

The new furnace unit is capable of producing ingot sizes from 9 to 24 in. in diam and serves as the heart of a complete facility for the manufacture of vacuum melted mill products.

In this method of vacuum melting, the use of a water-cooled copper mold completely eliminates contamination from refractories. Molten metal coming in contact with the cold mold surfaces solidifies instantly, and forms an insulating layer or lining that contains the metal subsequently deposited. The rapid cooling rate promotes progressive solidification which, with the application of suitable melting control, minimizes ingot defects such as segregation, pipe and porosity. Inclusions tend to float in the molten pool and concentrate in the top end of the ingot. Material from this section is readily cropped during conversion.

Vacuum arc melting can accomplish consolidation of reactive and refractory metals and alloys which are difficult or impossible to process by other means. It also has a very definite refining potential that, when applied to remelting of materials produced by conventional air melting procedures, can be expected to yield the following benefits.

1. Substantially lower gas content.
2. Improved cleanliness.
3. Comparative freedom from center porosity and segregation.
5. Closer control of chemical composition.
5. Improved hot workability.
6. Improved mechanical properties at elevated and room temperatures. This is particularly reflected in ductility, impact strength, fatigue strength, creep and rupture strength.

ROLLING MILLS

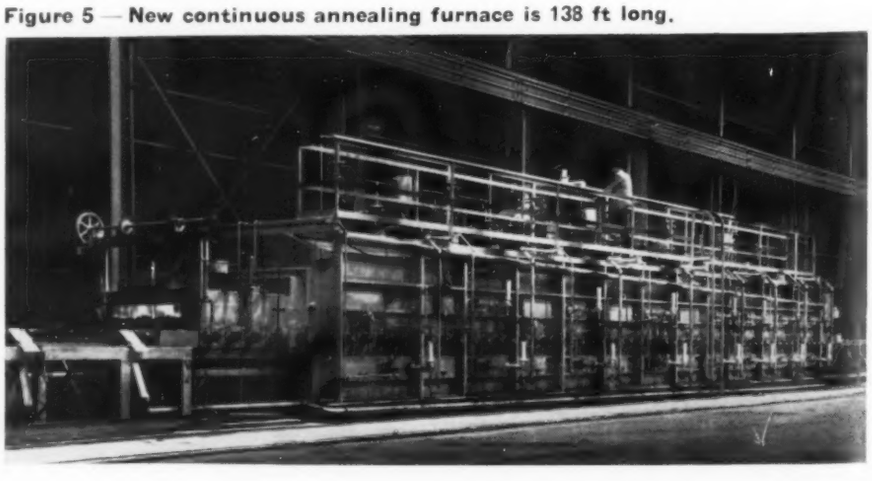
Installation of the new 16 in. and combination 12 and 10-in. rolling mills virtually doubles the conversion capacity of the Latrobe plant. The additional rolling mills ease the load on existing equipment, eliminating much time-consuming roll changing so that mill scheduling is faster and more flexible. Thus, delivery times are shortened, especially during periods of peak operation.

Ingots and billets as large as 7 in. are cogged and rounds from 2¾ to 5½ in. can be rolled on the 16-in. mill. The mill consists of two stands, 3-high, and one stand, 2-high. A 2½-ton charging machine delivers billets to the mill from six billet-heating furnaces nearby. After rolling, a roller conveyer transports the bars to a high-speed shear for cutting to the desired length.

The two other mills are mounted in combination with two 12-in. stands, 3-high; four 10-in. stands, 3-high; and one stand of 10 in., 2-high. They process billets into rounds from ¼ to 1⅛-in. With two reel coilers mounted on the 10-in. mill, wire rolling facilities are the finest in the tool and special steel industry.

The new setup makes it possible to roll wire from ¼ to ¾ in. diam.

Figure 5 — New continuous annealing furnace is 138 ft long.



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Coils with a 30 in. inside diameter and a 40-in. outside diameter weighing as much as 200 lb can be produced. A 100-ft roll conveyer will furnish bars and billets to the mill from a separate bank of six heating chambers similar to those used on the 16-in. mill.

The new rolling mills are powered by two 1000-hp electric motors. A specially designed gear box permits the operation of the 10 and 12-in. mills from one motor. Separate motors power the wire coilers.

Auxiliary equipment—Along with the increase in rolling mill equipment, the roll-turning shop has been modernized and expanded with the addition of an 18-in. roll-turning lathe and an additional grinder. A special Korfund spring suspension system is used to mount the lathe to isolate it from vibration and freedom from base movement, despite the fact that an 8-ton steam forging hammer operates less than 50 ft away. Three new cranes with a 10-ton capacity service the new mills.

Roller hearth annealing furnace—Immediately adjacent to the rolling mills is a new continuous roller hearth annealing furnace. Measuring 138 ft from the front feed table to the rear, the furnace enables Vanadium-Alloys Steel Co. to provide high-speed steel annealed to a specified hardness and free from harmful decarburization and oxidation. This can be done because the annealing cycle is conducted in a temperature range from 1100 to 1800 F under carefully regulated atmosphere control, which eliminates the need for laborious packing and time-consuming soaks in annealing tubes. The new furnace makes it possible to load steel at one end, with continuous rollers carrying it at an exactly determined rate through six temperature zones; each zone offering a controlled endothermic atmosphere for improved surface control of carbon. After furnace annealing, the steel is ready for further processing. With the close product control available in the new furnace, Vanadium-Alloys is able to furnish fine-grained tool steel in the annealed condition, free from harmful decarb and scale. The furnace is the first of its type to be placed in operation in a tool steel mill.

2000-TON PRESS

The installation of a 2000-ton vertical hydraulic forging press enables Vanadium-Alloys' Colonial Steel Co. Division to speedily handle much larger steel sections than could formerly be produced when all forging operations were performed by steam hammers and a blooming mill at Monaca. The new press forges ingots from 12 in. square, weighing one ton, up to those 40 in. square and weighing 10 tons. It is also used to make die blocks and disk forgings, and to flatten large bars, plates and other steel products, supplementing existing equipment.

The press has a working pressure of 4250 psi, a stroke of 48 in. and a ram diam of 35 in. With dies removed, the "daylight" dimension of the giant press is 108 in. The column centers provide an area of 90 in. left to right, by 52 in. front to back, with the clear distance between column shields, left to right, being 68 in.

Essential equipment of the press includes two 600-hp pumps, an accumulator tank or bottle which acts as the pressure tank, a prefill tank and a gravity tank. Because of the high pressures involved in the accumulator tank, it is constructed with 6-in. thick steel walls and weighs a total of 32 tons.

Ingots are supplied to the press from automatic temperature controlled heating furnaces. They are placed on the dies by a 10-ton floor-type charging machine. A 10-ton forging manipulator is used to handle the steel during the forging operations. An overhead 15-ton crane is also available to service the press. Two new annealing furnaces will handle the forgings after they leave the press. An interesting feature of the heating and annealing furnaces is electric-eye controls which open and close the doors automatically.

Use of the press will greatly speed-up deliveries of forgings and at the same time offer a more uniform product with better quality control. The press is located in a roomy, modern building containing some 20,000 sq ft of space, adjacent to the melt shop so that hot ingots can be moved directly into the press shop. Also nearby is a new billet-storage building complete with high-speed saws to facilitate fast and efficient handling of the various grades of alloy and die steels produced at the Monaca plant. ▲

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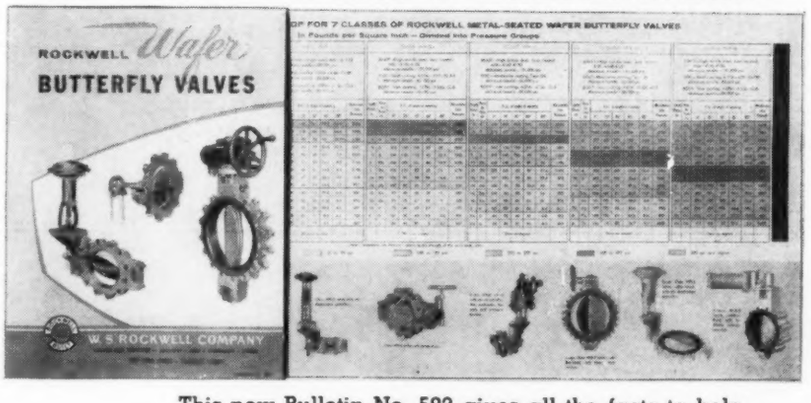

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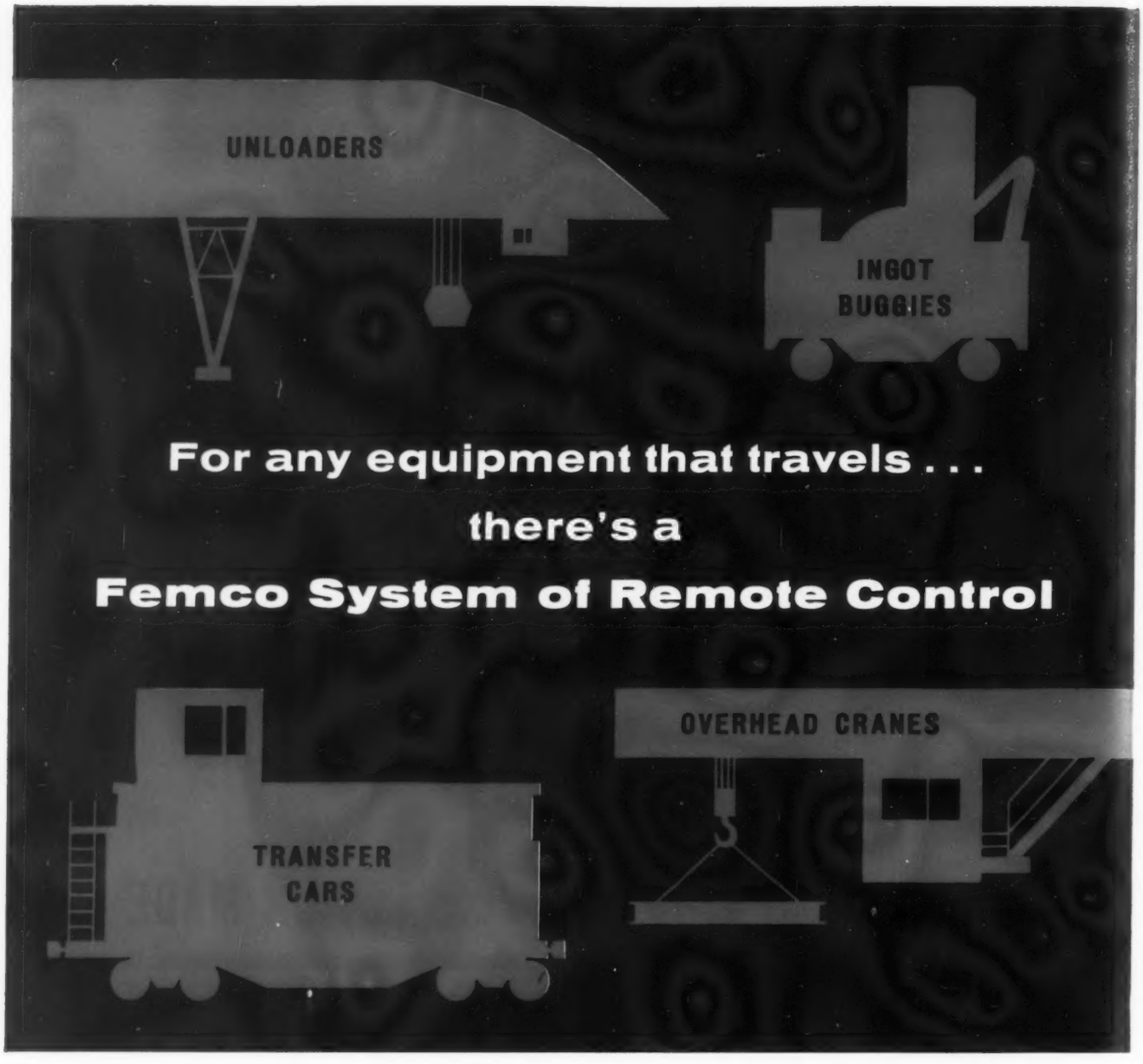

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Republic to Install New 56-In. Strip Mill at Warren Plant

REPUBLIC Steel Corp. will install a new 56-in. hot strip mill at its plant in Warren, Ohio. Representing an investment of more than $45,000,000, the mill will be designed not only for the efficient production of carbon steel sheets and strip, but for numerous other types of sheets including special grades of stainless steel now being developed for aircraft and missiles.

The mill is the first major project to be undertaken as part of Republic's $375,000,000 modernization and expansion program announced at the company's annual meeting of stockholders in Flemington, N. J., on May 13, 1959.

Expected to be in operation the latter part of 1960, the new mill will have a capacity to roll 145,000 tons per month. It will replace a present 42-in. mill with a capacity to roll 85,000 tons per month.

The new mill will be extremely versatile, able to handle all the standard grades of carbon steel necessary to produce sheet and strip up to finished widths of 48 in. Practically all of the hot rolling of stainless steel will be done on this mill except for the very wide sheets over 48 in. which will continue to be processed on the 98-in. mill in Cleveland. It will be able to produce silicon steel sheets with better control of grain structure, essential in a good quality product. It will be able also to roll sheets from low alloy steels and titanium.

The new mill will consist of heating furnaces, a scalebreaker, a reversing roughing stand, six finishing stands, a runout table and two coilers. Equipped for high speed operation, the mill will permit steel to leave the last finishing stand at speeds up to 2300 fpm.

The mill will permit the rolling of large, heavy steel coils minimizing the need for welding coils together for subsequent cold rolling operations.

Eight big electric motors will drive the new mill ranging from 3500 to 7000 hp and have a total combined horsepower of 41,000.

A new building to be erected to house the mill will have more than 300,000 sq ft of floor space. It will be located immediately west of the plant's present cold strip and silicon strip building. Work on the project will get underway as soon as possible. The project is not expected to change employment totals at the plant.

The present 42-in. mill will continue in production until the new mill is completed. It will then be dismantled and the space it now occupies will be utilized for additional finishing facilities. This mill first operated in 1927 as a 30-in. mill, was rebuilt and widened out in the '30s. Historically it is of interest for it was one of the first continuous hot strip mills to be built in the steel industry. Prior to the construction of this and two mills built by other companies at about the same time, steel sheets were produced on the familiar hand mills, now virtually out of existence in the rolling of steel. The old Warren mill was the prototype for the design of Republic's 98-in. continuous hot strip mill built in 1937 and still the widest such mill in use in the steel industry. ▲

Figure 1 — Construction of the new 56-in., $45,000,000 hot strip mill will get underway soon. The mill will have a capacity to roll 145,000 tons per month. T. F. Patton, right, president of Republic, discusses the location with E. R. Johnson, vice president in charge of operations.

Lukens Completes Large Expansion Program

LUKENS Steel Co. recently completed its greatest single expansion program in its 149-year history. At a total cost of $33,000,000 Lukens has increased its steelmaking capacity by 24 per cent (to 930,000 ingot tons annually) and raised its plate-rolling facilities by some 40 per cent to become the third largest producer of steel plate in the nation.

Especially important is a new 140-in. plate slabbing mill. The 4-high reversing mill has a maximum separating force of 12,000,000 lb powerful enough to make a 4-in. reduction in the thickness of a heavy carbon steel ingot in a single pass through its 140-in. wide rolls. Yet the mill controls are so sensitive that an operator can electronically adjust the roll opening by increments as small as 0.01 in.

Equally important is a new electric steelmaking furnace producing up to 100 tons of quality carbon or alloy steel in a single heat.

The third major part of the expansion program are 12 new soaking pits. Each pit can hold individual ingots weighing up to 61 tons apiece.

140-IN. MILL

The 4-high reversing mill is designed for automatic control. Once on the entry table, an ingot can pass back and forth through the rolls, the rolls can be successively screwed down, and the ingot can be rolled to any predetermined size without an operator's touching a single control. At any point in the sequence, however, an operator can take over through manual controls.

The mill layout includes a vertical edging mill with two 37-in. nominal diameter vertical work rolls. The mill can edge roll material weighing up to 60,000 lb and measuring up to 140 in. wide and 30 in. high. The maximum draft is 2 in. The vertical rolls are designed to squeeze the ingot edges and to break up surface scale.

The new 140-in. mill is completely integrated with other Lukens rolling facilities including another 140-in. and a 206-in. rolling mill. The new mill increases Lukens' total plate rolling capacity by an estimated 40 per cent. Listed below are some of the most important features of the new mill:

Power source—New in the United States, and only the second of its kind in the world, is the power source that drives the mill rolls—two "back-to-back" connected 8000-kw rectifiers that supply direct current to the mill's two main reversing drive motors.

The first rectifiers so connected and used for reversing service were installed in a West German plate mill. A third rectifier system of this type is also scheduled for installation in West Germany.

Other reversing mills in the United States convert alternating current to direct current through a system of motors and generators. The new rectifier system at Lukens offers a number of advantages:

1. It requires no heavy foundations.
2. It requires no heavy crane for installation or maintenance.
3. It does not require any fixed layout and therefore may be fitted into virtually any convenient mill space.
4. The rectifiers are water cooled and therefore require no ventilating air.
5. The inherent overload capacity of rectifiers is far greater than that of conventional motor-generator systems.
6. Rectifiers are more efficient from a power cost standpoint, operating at about 94 per cent efficiency compared with about 85 per cent for motor-generator systems.

Figure 1 (left) — The new 140-in. slabbing mill raises Lukens' plate-rolling capacity by 40 per cent. Figure 2 (right) — For its new 140-in. slabbing mill, Lukens Steel Co. has designed two new ingot buggies which, through a unique set of handling arms, are able to lay an ingot down in either direction and then transport it at speeds up to 500 fpm.

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NO MOVING PARTS Ultraflex Packaged Drives work perfectly without forced ventilation . . . less power wasted as unwanted heat. No power robbing friction or windage losses. A closed-loop voltage regulation system, current limit control, and static field excitation insure peak operational efficiency.

NO MOVING PARTS Simple static power conversion units cut maintenance costs. With Ultraflex there are *no* bearings, commutators, or brushes to service. *No* shafts to align or couplings to maintain. *No* inertia loads to balance. *No* fans or filters to clean or change.

Standard Ultraflex Drives provide an 8:1 speed range with wider ranges available upon request. Optional features include dynamic braking, jogging, reversing, tachometer-generator speed regulation, etc. Get all the facts, and see how a Cutler-Hammer Ultraflex Packaged Drive can provide outstanding savings in installation, operation, and maintenance. Write today for new bulletins EN64-M232 and EN65-M232. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

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Figure 3 — The two main mill drive motors are integrally ventilated and cooled with filtered air to keep out dirt, thereby eliminating the need for a separate and space-consuming motor room.

Figure 4 — Bank of 12 of the 96 ignitron tubes, vital parts of the two back-to-back connected 8000-kw rectifiers that supply direct current to the two main reversing drive motors of the 140-in. slabbing mill.

7. Rectifiers are, in a sense, self-replacing. That is, when a part fails, that part alone is replaced. In the course of ten years service, for example, virtually every major part may have been replaced with no significant amount of down-time involved.
8. Rectifiers offer faster and more precise control of the reversing mill rolls.

Because the vertical mill rolls do not work while the horizontal rolls are working, and vice versa, the same power source is able to drive motors delivering power to both vertical and horizontal mills—a considerable cost-cutter in itself.

Mill drive motors—Another unique feature of the power source is the fact that the main mill drive motors have been placed in full view on the mill floor without being installed in a separate motor room—a considerable space-saver. To keep out dirt, the motors are integrally ventilated and cooled with filtered air under higher pressure than the outside atmosphere.

The twin motors driving the horizontal mill rolls are rated 5000 hp at 40 to 80 rpm. The motor driving the vertical mill rolls is rated 3000 hp at 70 to 175 rpm.

Mill housing and screwdown mechanism—Although the mill housing is extremely stiff and rigid, it fully reflects the trend toward more compact and more efficiently designed units of this kind.

The outstanding feature is its screwdown drive, which has a completely unique clutch device. In place of conventional magnetic or mechanical clutches, the screwdown drive uses an air clutch that transmits torque of 9000 ft-lb to run the screwdown. These clutches are disengaged to level the mill. The new air clutch is normally closed, has less kinetic inertia and does not rely on electric current for normal mill operation. In addition, it is more compact than conventional clutches and offers many safety features as well.

Another unique feature of the vertical mill housing is the manner in which power is delivered to the vertical rolls themselves. These are top driven, instead of being driven from underneath. Simpler to maintain, this arrangement also eliminates wear from falling ingot scale.

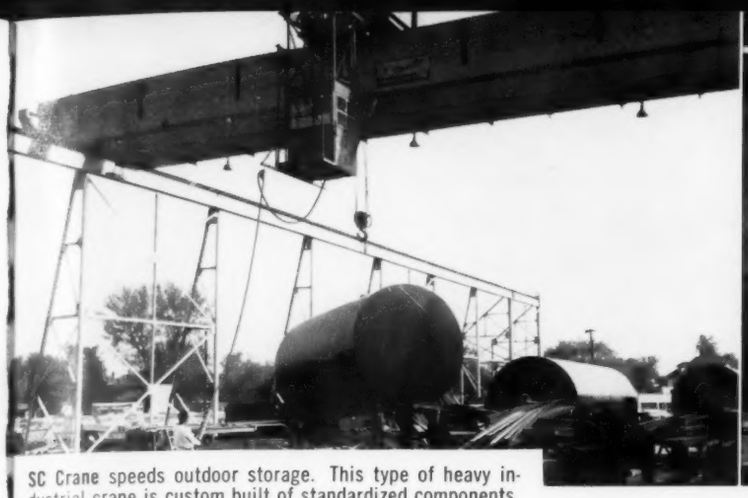
High pressure descaling system—Lukens is the first American steel plate mill to use water delivered under extremely high pressure to descale slabbed ingots.

Spray headers mounted above and below the horizontal mill table rolls deliver cold water with a pressure of 1500 psi at the nozzle at full flow to remove scale. The spray headers are mounted close to the upper and lower work rolls and, like the rolls, are controlled by the screwdown drive to keep the nozzles a uniform distance from every slab whatever its gage may be.

The spray headers are fed by two 1600-psi split-case multi-stage pumps delivering water at the rate of 1000 gpm.

Cold water descaling at pressures as high as 1500 psi was introduced in West Germany. No American cold-water plate descaling system operates at higher than 1000 to 1200 psi at present.

Scale flushing system—In the system for removing scale accumulating under the mill and table rolls, a unique system of flumes has been built and lined with cast basalt blocks. These blocks, furnished by Schmerlzbasaltwerk Kalenborn, are extremely abrasion-resistant. Sus-



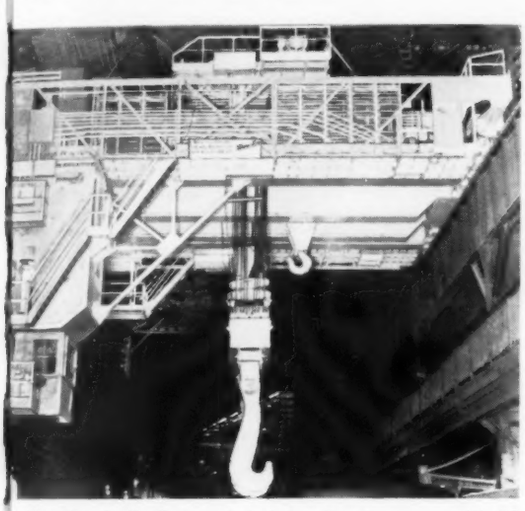
SC Crane speeds outdoor storage. This type of heavy industrial crane is custom built of standardized components. Capacities range from 5 to 40 tons; spans to 120 feet. 3 or 4 motor. Floor or cage operated.

SB Crane on the job in a steel warehouse. This class of standardized crane is built in capacities from 5 to 40 tons; spans to 100 feet. Many built-in "plus values" insure top performance and low operating costs in the severest service.

PROOF

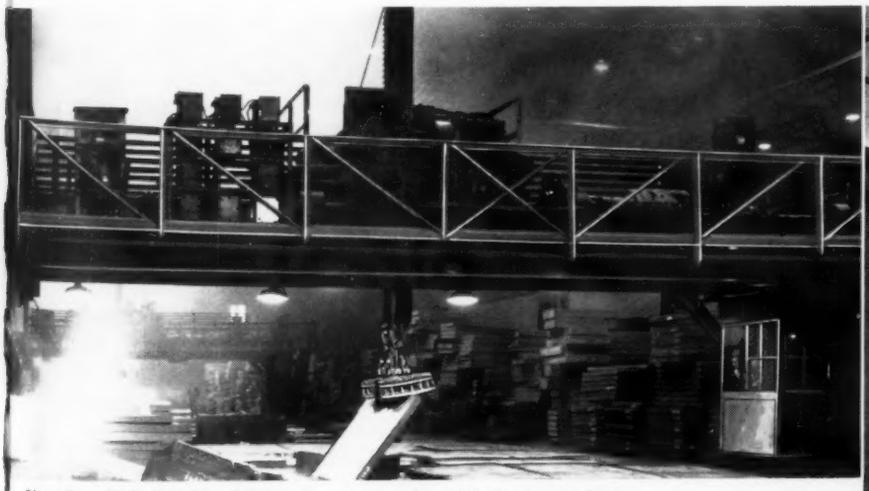
of Shaw-Box Crane quality and reliable performance is evidenced by more than 70 years of rapidly growing acceptance from all kinds of industries.

We build all types of cranes to AISE specs or to meet individual standards of structural durability and operational efficiency and economy. Your inquiry is invited.

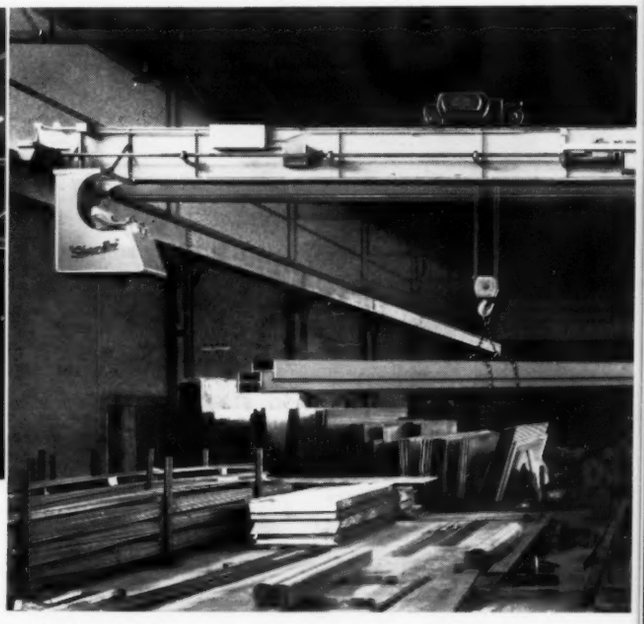


Shaw-Box Ladle Crane. A 4-girder, 9-motor crane with 54 foot span. 90-ton ladle holds 200 tons of molten steel. 75-ton auxiliary trolley handles lighter loads.

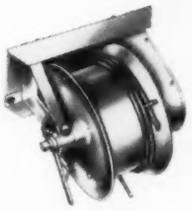
Shaw-Box Bucket Magnet Gantry Crane. Our gantries are serving the steel industry to handle plate, slabs, and scrap. We build them for other industries as well, in any desired capacity.



Shaw-Box Slab Turning Cranes do a tremendous job in conserving manpower and reducing costs around the clock. Rigid, non-whipping construction is combined with the utmost resistance to impacts.



Series "D" Load Lifter Cranes. Capacities to 20 tons, spans to 80 feet. Designed for average industrial service. Components are so highly standardized, you can buy your crane from a catalog.



Soaking Pit Cover Carriages are not only made by Shaw-Box, but we also produce the reliable spring drive cable reels that supply current to the carriages. These reels are also widely used on magnet equipped cranes.

ELECTRIC OVERHEAD CRANE INSTITUTE E.O.C.I. MEMBER

59K-1-A

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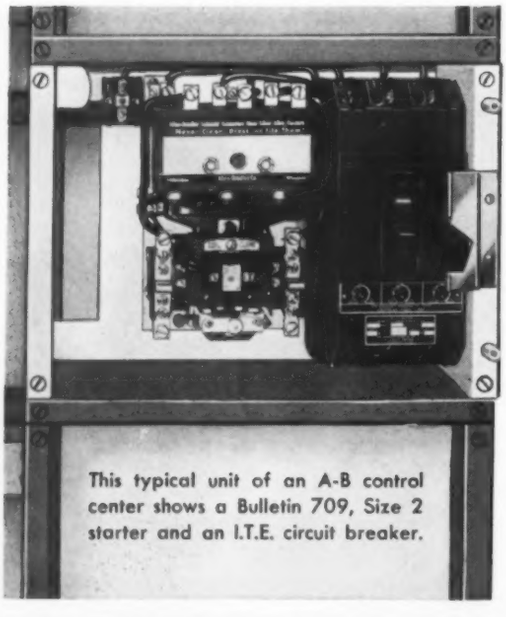


This typical unit of an A-B control center shows a Bulletin 709, Size 2 starter and an I.T.E. circuit breaker.

Allen-Bradley control centers are the "label" of a modern plant. They make neat, centralized installations and—where this is practical—do away with individual starter mountings and complicated wiring. The control center may even reduce installation cost—as compared with using individual starters. Here are some of the up-to-date design features which make the A-B control centers so popular.

NEW SPACE SAVING DESIGN—New Bulletin 798 control centers save floor space . . . provide up to 8 units in a 90" high control center unit.

PREMIUM QUALITY FINISH—An exclusive A-B finishing process assures that your control center will retain its attractive appearance over the years. Each piece is *individually* cleaned and phosphated *before* assembly—there are no "bare spots" where corrosion can have a start. Then a rust-resisting primer and a dense finish coat are baked on, providing a fine, tough, and lasting surface.

FLEXIBILITY—A-B control centers are readily adaptable to changes in operating needs—integral plug-in units can be added or modified without internal rewiring. Entire sections are easily added as needed.

SUPERIOR PERFORMANCE—Using the popular A-B solenoid starter—with only ONE moving part—assures millions of trouble free operations. Their double break, silver alloy contacts *never* need servicing.

For "tops" in control centers, you owe it to yourself to investigate Allen-Bradley's Bulletin 798. Write for complete information.

ALLEN-BRADLEY

MEMBER OF NEMA

Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

Figure 5 (left) — The new 100-ton electric furnace raises the company's total steelmaking capacity by 24 per cent from 750,000 to 930,000 ingot tons annually. Figure 6 (right) — Rubber-tired trucks, instead of conventional rail charging cars, perform certain charging jobs at Lukens Steel Co.'s new 100-ton electric furnace.

pended in water, the scale is rushed out through the flumes. Upon hitting a pit big enough to reduce the water velocity, the scale settles out and the water is recirculated through the flume. Make-up water for the system is provided by the high-pressure descaling spray.

Entry and delivery tables—Reflecting practice in Europe and America, the entry and delivery tables for both the vertical and horizontal mills have individual motors driving each roll. Individual motors eliminate the need for gears and line shafts, sharply reducing lubrication and other maintenance problems.

In addition, the feed rollers delivering the ingots to work rolls are also individually driven. This is done by transmitting power from individual motors through holes in the mill housing. Thus further maintenance savings are possible by eliminating the need for mechanical gear trains geared to the last table rollers.

Ingot buggies—Lukens has installed two new ingot buggies which, through a unique set of arms, are able to lay an ingot down in either direction and then transport it at speeds up to 500 fpm. Lukens developed the new buggy from a stationary table which a visiting team of Lukens engineers inspected in West Germany.

Control equipment—The highly complex network of electrical wiring, water piping, lubricating lines and auxiliary supporting equipment for the mill is installed in a multi-level cellar under the mill floor. The floor itself is made of reinforced concrete three ft thick, insulated with used furnace brick and slag so that hot slabs can be stored on it before further processing. The entire floor is supported by structural beams.

The mill stand rests on a concrete foundation which, in turn, rests on solid bedrock.

Every opening to the areas below the mill floor is protected by raised concrete walls, and all doors giving access to cellar areas are gasketed. As an additional safeguard, high capacity pumps have been installed to keep every cellar area bone dry even if the mill floor itself should be under four feet of water.

ELECTRIC FURNACE

The new electric steelmaking furnace can produce up to 100 tons of steel in a single heating cycle, it has a rated capacity of 180,000 ingot tons.

In the course of breaking-in the new furnace, the average heating cycle from cold charge to tapping was just over five hours. The cycle as measured from one tapping to the next averaged under six hours.

The average power consumed in a cycle was approximately 50,000 kwhr per heat with the furnace electrodes drawing an average current of 35,000 amp.

The electric furnace building houses an air-conditioned chemical laboratory completely equipped with a direct-reading spectrometer to give a complete analysis of up to twelve elements in less than eight minutes including time to pour, cool, and prepare the specimen. By contrast, it used to take more than one hour using wet tests to get an analysis of manganese content alone.

The quick availability of chemical analysis data affords ample opportunity to insure a specific heat's meeting any predetermined analysis requirements.

The design of the building includes an elevated charging floor. This creates an entire area underneath for necessary service shops and materials storage and leaves the charging floor itself entirely free for charging operations. Instead of cars on tracks, rubber-tired trucks perform certain charging jobs. High

Figure 7 — New 100-ton electric furnace plant uses the Tiger system for forming hot tops in less than 90 sec once the proper mixture of sand and calcium silicate is set in place in the ingot mold and carbon dioxide is blown through it.

storage bins hung on the charging floor wall for lime and dolomite take advantage of the ample headroom to conserve floor space. A separate bay, level with and parallel to the charging floor, permits rapid access to electrodes and alloy addition storage.

The furnace design also provides an efficient arrangement for handling scrap. The entire scrap assembly area is laid out parallel to the furnace line adjacent to the charging floor. In addition to safety advantages, scrap material is moved quickly to the furnace with minimum interference to other operations on the charging floor.

For such reasons, it can take less than 15 min to completely charge the furnace with its full load of 112 tons of material. The scrap crane has a capacity of 50 tons.

Greatly adding to the furnace building's over-all efficiency is the installation of a Tiger system for building hot tops on ingot molds. Located hard by the pouring pit bay, the Tiger system forms a complete hot top in less than 1½ min after the proper mixture of sand and calcium silicate is set in place on the ingot mold and carbon dioxide is blown through it. In addition to making better and cheaper hot tops, the Tiger procedure has resulted in improved pouring qualities and better yield from electric furnace ingots.

The spaciousness of the building permits the handling of strings of furnace electrodes up to 21 ft in length with no difficulty.

The furnace itself, in a sense, operates with a minimum of human supervision. Once the power is turned on, the position of the electrodes is automatically adjusted to get any predetermined arc power.

SOAKING PITS

After extensive research into modern ingot-heating practice both in the United States and abroad, Lukens has built a total of twelve new pits that establish new records for size, total capacity, and for their ability to handle individual ingots of massive size. Each pit is 17 ft 9 in. deep, 25 ft 6 in. long, and 11 ft 6 in. wide—big enough to hold up to 180 tons of steel ingots and heat them to temperatures in excess of 2300 F.

Each pit can handle individual ingots standing 10½ ft high, measuring 40 in. thick, and weighing up to 61 tons apiece—the largest ingots that can be rolled into finished steel plate. Each pit is one-way fired, with horizontal jets of flame 10 ft long clearing even the tallest of ingots with a minimum space of 3 ft 6 in. between the ingot top and the center of the flame.

The pits are designed to fire both natural gas and oil (Bunker C grade) as fuels.

Another key feature is the use of metallic recuperators. The temperature of waste gas as it enters the recuperator averages about 1600 F and 600 F when it leaves.

Another unique feature of the soaking pit line is the handling crane that services the pits. The 75-ton stiff-leg crane is the largest of its type ever built. In addition, it uses a new unitized electrical collector system to prevent misalinement of sliding shoes with collector rails. In earlier installations, misalinement frequently resulted from shocks and variations in the crane trolley's operation.

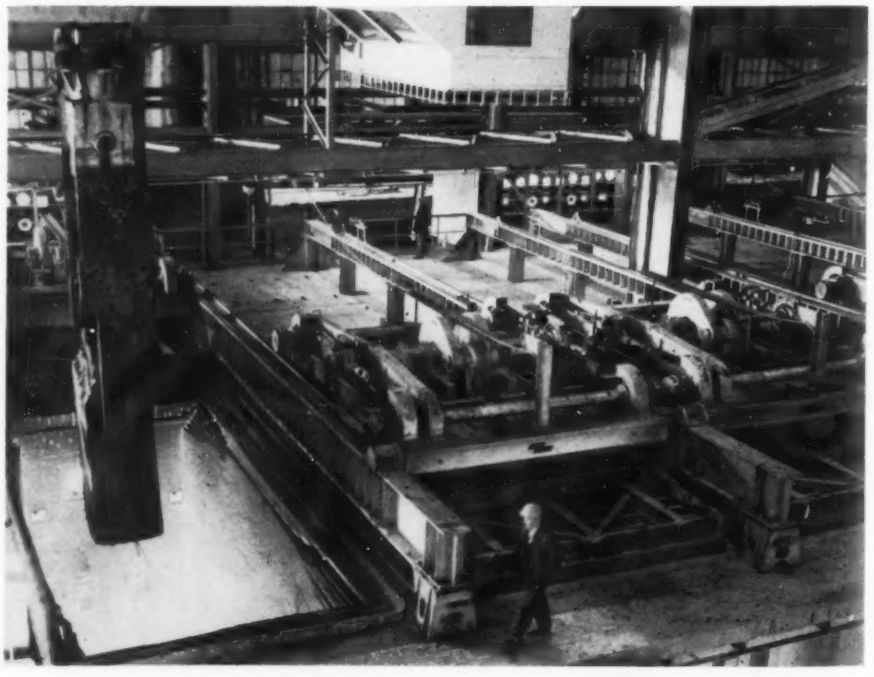
Another new feature of the crane is an automatic braking device that becomes operative as the trolley approaches track-ends.

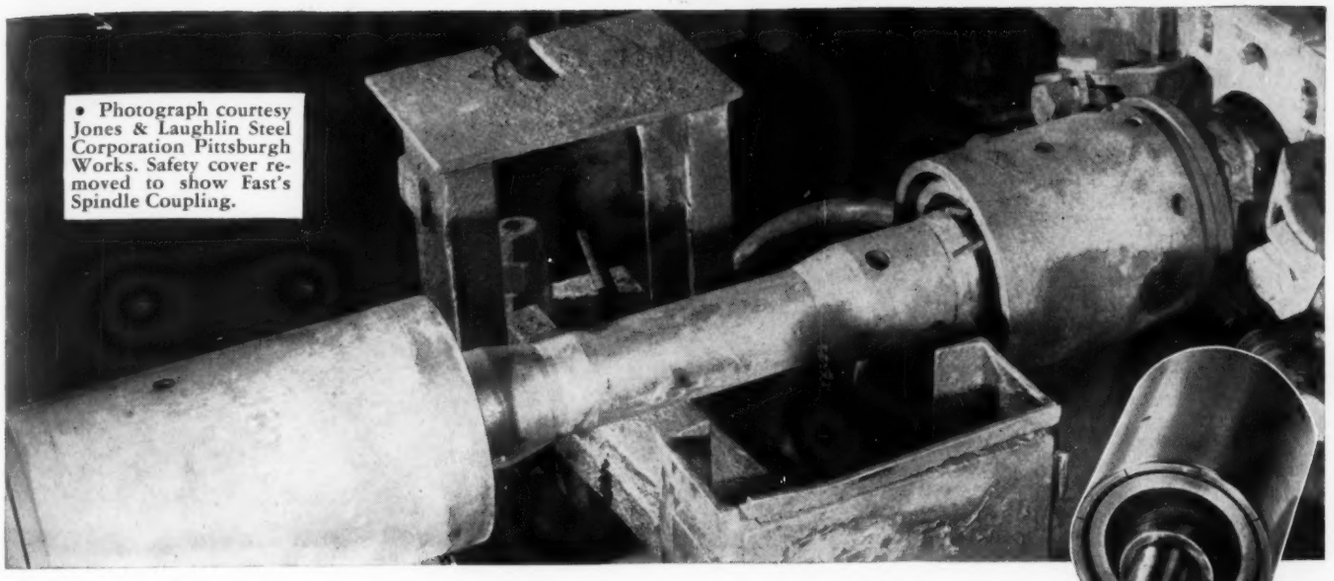
For efficiency of operation, the crane operator can open and close the pit covers from his cab, eliminating the need for floor personnel for this job.

By providing adequate space below the pits, with room for a fork truck to maneuver, and with access to an auxiliary crane, all routine maintenance on the pits—digging bottom, cleaning and replacing recuperators, changing covers, etc., is carried out without utilizing the main ingot cranes.

Lukens is heating a wide variety of types and sizes of steel ingots in its new soaking pits. Despite this variety, the new pits have, from a cold charge, produced an average of 6 tons per hour per pit requiring an average of less than 1,500,000 Btu, or 1500 cu ft of gas, per ton. ▲

Figure 8 — New soaking pit line has established new records for total capacity and ability to handle individual ingots of massive size.





• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
★ *Quicker Disassembly*
★ *Bigger Savings on Maintenance*

The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 5006 Scott Street, Baltimore 3, Maryland.

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Sold with *Service*

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FAST'S Couplings

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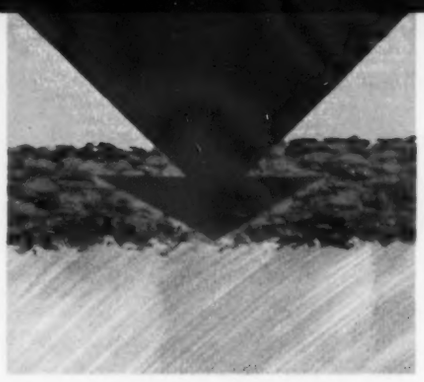
RUST PREVENTIVE
STOPS RUST!®
BEAUTIFIES AS IT

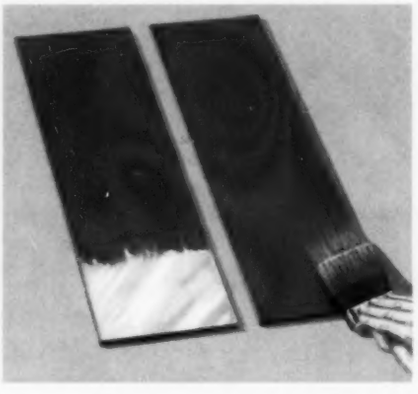
take brush!

Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surfaces. Saves costly surface preparations—lasts and lasts.



The **specially-processed** fish oil vehicle in the primer penetrates rust to bare metal—as proved in radioactive tracing studies.

Rust-Oleum, in its many forms, resists rain, fumes, heat, moisture, sun, and general weathering to stand up over the years.



Up to 30% more coverage with Rust-Oleum, depending upon the condition and porosity of the surface. Another Rust-Oleum difference.

See the many Rust-Oleum DIFFERENCES yourself!

Rust-Oleum primers and finish coatings are easily applied by spray. Flows smoothly . . . may be used in conventional, hot spray, or high pressure air-less spray.

A few easy strokes of the brush proves more than a thousand words . . . see how smoothly Rust-Oleum flows on . . . no pull, no drag . . . and it dries free of brushmarks. See, too, how much more coverage Rust-Oleum gives you . . . up to 30% more area depending upon the condition and porosity of the surface.

If your metal surfaces are *rusty* – simply brush or spray Rust-Oleum 769 Damp-Proof Red Primer right over the sound rusted metal after scraping and wirebrushing to remove rust scale and loose rust. The *specially-processed fish oil vehicle* in the primer penetrates rust to bare metal—driving out air and moisture. Easy as that to Stop Rust—and save time, money, and metal.

For *lasting beauty* – follow up with a Rust-Oleum finish coating in the color of your choice – from grays, greens, blacks, and aluminums to yellows, blues, whites, or browns – or from the many popular pastel shades.

That is the Rust-Oleum *System* of primer and finish coat for maximum over-the-years protection. A system that is measured by the money you save. Specify Rust-Oleum for maintenance, new construction, and re-modeling. Your Rust-Oleum Industrial Distributor maintains complete stocks for prompt delivery . . . he will be happy to consult with you on your coating problems.

What is your coating problem? What **color** do you need? Get lasting beauty in the color of your choice. Mail coupon for color charts.

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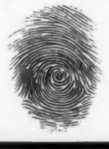

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- ☐ Complete literature with applications and color charts.
- ☐ Information on matching special colors.
- ☐ Thirty-page report on Rust-Oleum fish oil penetration.

Feller Engineering Co.

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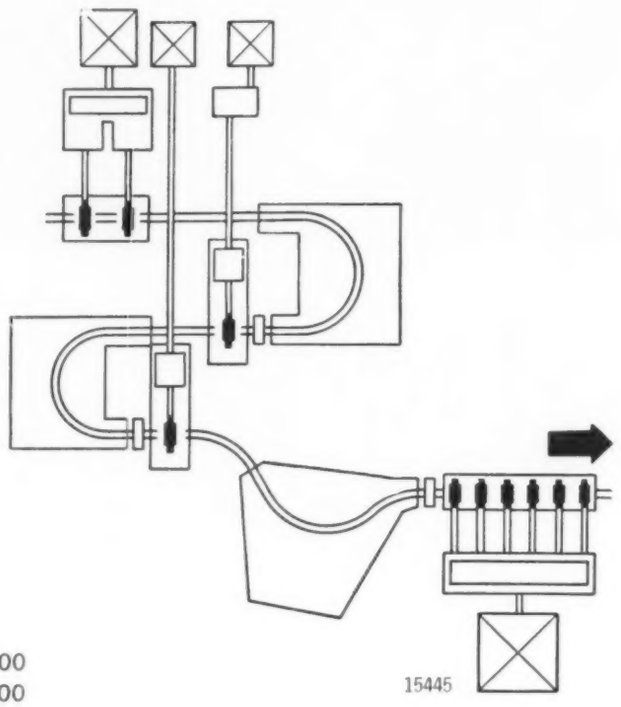
SCHLOEMANN

Wire rod and merchant mills

What is the cost

of closer rolling tolerances for wire rod?

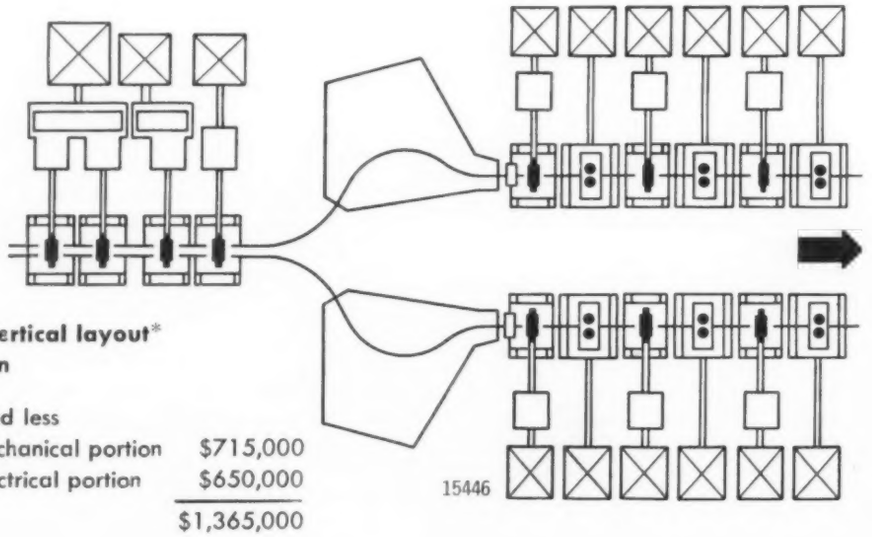
The following two typical arrangements may serve as examples when discussing the suitable layout of a wire rod mill.



With a two-high twist layout* of the finishing train

Tolerances ± .010 or higher

Budget Estimate	mechanical portion	$410,000
	electrical portion	$240,000
		$650,000



With a horizontal-vertical layout* of the finishing train

Tolerances ±.008 and less

Budget Estimate	mechanical portion	$715,000
	electrical portion	$650,000
		$1,365,000

Explanation

Assume that wire rod is being rolled in a two-high twist mill with a tolerance of ±.012 and in a horizontal-vertical mill, with a tolerance of ±.006. With conditions identical as regards final section, rolling speed and roll diameter, the closer tolerances for the last ten passes would require, for the mechanical and electrical parts alone, an additional cost of $715,000. Careful consideration must therefore be given to operating as well as initial costs in deciding which mill to select.

* Reference is made to the following publications on plants built by SCHLOEMANN:
"Three rolling mills with finishing trains in two-high twist layout." (April Issue)
"Three rolling mills with finishing trains in H/V layout." (May Issue)

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

Kaiser Doubles Napa's Pipemaking Capacity

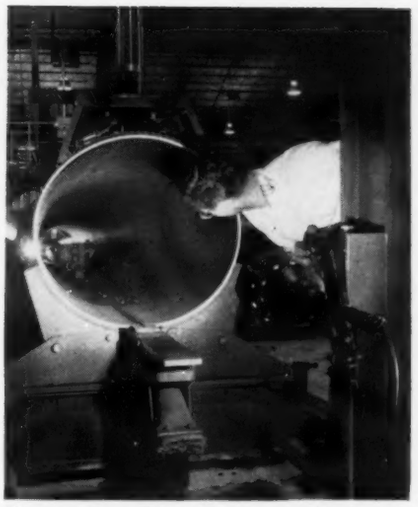


Figure 2 — To assure quality and strength, each piece of pipe received a double pass weld, inside and out. There are nine twin tandem submerged arc welding machines, above, and seven outside welding machines at Napa. The boom welder, above, travels five fpm.

The official completion of a $2,000,000 expansion of facilities at Kaiser Steel's Fabricating Division plant at Napa, Calif., was announced late in May. The 18-month expansion doubles the Napa plant's pipemaking capacity and makes it one of the largest plants in the world for manufacture of line pipe for oil and gas transmission.

The new facilities make it possible for the Napa plant to produce expanded electric weld line pipe from 20 up to 36 in. in diameter, and the size range of the pipe manufactured at the plant can be increased up to 42 in. outside diameter if demand warrants. The Napa plant also manufactures electric resistance weld pipe from 6⅝ to 20 in. in diameter.

Steel plate for the pipe is rolled at Kaiser Steel's Fontana, Calif., plant where a $214,000,000 expansion was recently completed. One of the key facilities in the Fontana expansion was the construction of a new plate mill which resulted in increased plate capacity. This new mill can roll plate up to 132 in. wide for use in the manufacture of large diameter line pipe.

The major new facilities in the Napa expansion include a 50,000 sq ft addition to the pipe mill to house additional welding, facing, expanding and testing facilities, and storage areas. The biggest single piece of new equipment is the plant's second hydraulic expander, a 60-ft long machine which encloses the welded pipe while water is pumped in, at pressure testing the soundness of the weld, giving the pipe its final diameter, and increasing its tensile strength by a cold working of the steel.

There is a new overhead magnetic crane to feed plate to the forming line and a second complete finishing line where the pipe is welded, expanded, end finished, inspected and handled for shipping.

Figure 1 — The $2,000,000 expansion makes Kaiser Steel's Fabricating Division plant at Napa, Calif., one of the largest plants in the world for manufacture of large diameter line pipe for oil and gas transmission.

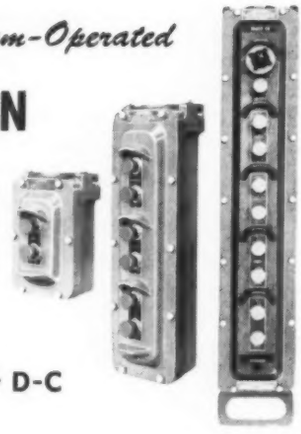
The forming line—first step in pipe manufacture—shapes 40-ft long plate into pipe at the rate of a piece a minute. After manual tack welding, the pipe is routed through the mill's 16 automatic inside and outside welding machines. It is then expanded under pressures up to 5000 psi to size and straighten each piece. Before leaving the mill each length of pipe is tested to specifications and subjected to a rigid final inspection by Kaiser Steel personnel before being turned over to the customer for his own inspection and acceptance.

In addition to the production of pipe, the Napa plant is also one of the largest and most diversified steel fabricators in California. It fabricates everything from plant machinery to sea-going barges. One of the jobs now under way is the manufacture of the major machinery for a pipe mill for the Japan Steel and Tubes Co. near Tokyo. This includes the manufacture of forming line equipment, welding equipment and a hydraulic expander and straightener. One of the recent additions to the fabricating facilities has been a new pit-type lathe designed and built by Napa personnel. The new lathe makes it possible to machine fabrications weighing 125 tons, up to 40 ft long and 17 ft in diameter. It is the largest installation of this type west of the Mississippi. ▲

For Hazardous Locations

Heavy-Duty, Cam-Operated

PUSH-BUTTON STATIONS



600 Volts
A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations for all applications that necessitate NEMA Types 7 and 9 enclosures to meet hazardous-location requirements. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

Sturdily constructed to withstand hard usage and abuse, their small cross-section permits comfortable, non-fatiguing, one-hand operation. Where required, a bottom holding handle can be supplied. The dense cast-aluminum enclosure can be readily opened for inspection of the silver-to silver contacts without disturbing any wiring. The conduit hole is threaded and a double-suspension cable hanger is provided.

Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

ASK FOR BULLETIN 2017

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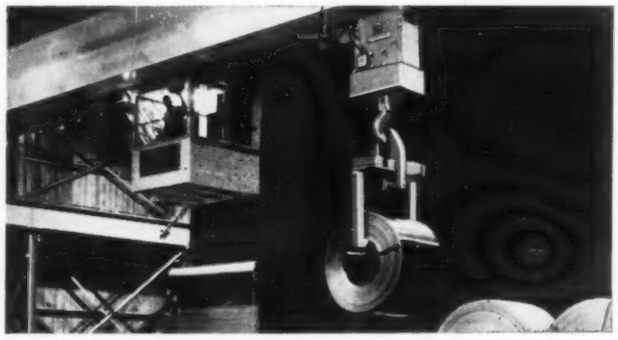
EXTRA HIGH and CLOSE PILING

The Mansaver style 1418 motor-driven coil grab illustrated below can stack coils evenly, close together and higher because of its telescoping construction. This factor increases floor space and provides more manufacturing area. The 1418 pictured is suspended from a Mansaver 1588 motorized crane hook with collector rings supplied for carrying current to the grab.



Mansaver's Motorized Crane Hook can be hung from your present hook or preferably with built-in sheaves for low headroom and increased stability. A full 360 degree rotation is provided, increasing storage areas by positioning materials more efficiently. Hook proper can be swung at any point in its rotation. Mansaver low headroom motor-driven crane hooks are in operation in capacities from 2,000 to 100,000 pounds.

CHECK THE ITEMS YOU HANDLE AND SEND FOR LITERATURE AND MORE COMPLETE INFORMATION.

☐
SHEETS

☐
COILS

☐
BARS

☐
BILLETS

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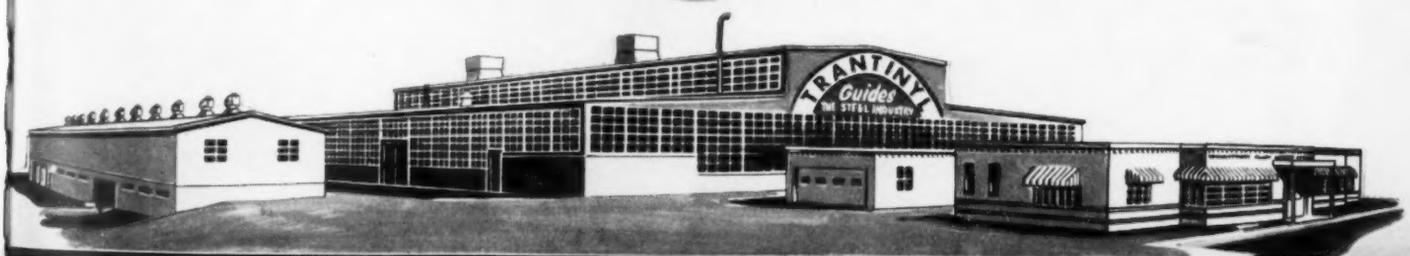
Also Manufactured in England

TRANTINYL

guides the steel industry



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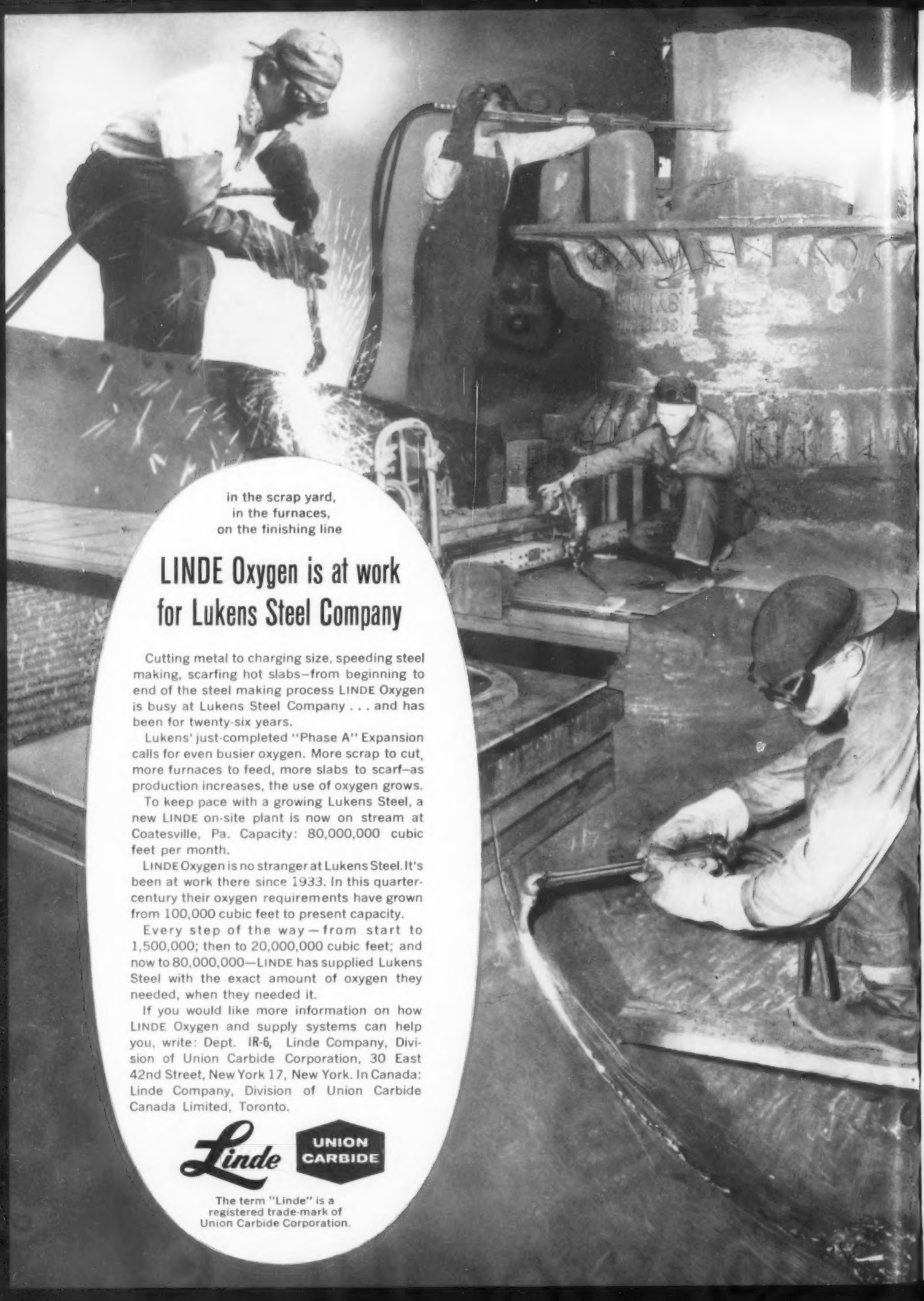
ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS



in the scrap yard,
in the furnaces,
on the finishing line

LINDE Oxygen is at work for Lukens Steel Company

Cutting metal to charging size, speeding steel making, scarfing hot slabs—from beginning to end of the steel making process LINDE Oxygen is busy at Lukens Steel Company . . . and has been for twenty-six years.

Lukens' just-completed "Phase A" Expansion calls for even busier oxygen. More scrap to cut, more furnaces to feed, more slabs to scarf—as production increases, the use of oxygen grows.

To keep pace with a growing Lukens Steel, a new LINDE on-site plant is now on stream at Coatesville, Pa. Capacity: 80,000,000 cubic feet per month.

LINDE Oxygen is no stranger at Lukens Steel. It's been at work there since 1933. In this quarter-century their oxygen requirements have grown from 100,000 cubic feet to present capacity.

Every step of the way—from start to 1,500,000; then to 20,000,000 cubic feet; and now to 80,000,000—LINDE has supplied Lukens Steel with the exact amount of oxygen they needed, when they needed it.

If you would like more information on how LINDE Oxygen and supply systems can help you, write: Dept. IR-6, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York. In Canada: Linde Company, Division of Union Carbide Canada Limited, Toronto.

Linde UNION CARBIDE

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Date-line Diary...

May 4

△ The AISI reports that the operating rate of the steel industry for the week of May 4 is scheduled at 2,668,000 tons (94.2 per cent of capacity). This compares with 2,627,000 tons one week ago (92.8 per cent capacity) and 1,334,000 tons one year ago. Index of production for the week is 166.1

△ Auto production in April, 1959 rose to 578,825 cars, slightly ahead of March, 1959, and 83 per cent over April, 1958.

△ American Iron Ore Assn. reported Lake Superior shipments of iron ore for April, 1959 amounting to 2,978,023 gross tons compared with 62,560 gross tons in April, 1958.

△ American Iron Ore Assn. reports that the consumption of iron ore in the U. S. for the first quarter of 1959 totaled 31,050,600 gross tons; receipts for the same period totaled 9,741,203 gross tons; stocks on hand on March 31, 1959 amounted to 43,171,061 gross tons.

May 5

△ The AISI reported that shipments of finished steel products for March, 1959 totaled 8,117,688 net tons.

△ National Steel Corp. filed a registration statement with the S.E.C. covering a proposed issue of $80,000,000, 4⅝ per cent first mortgage bonds, due 1989. Proceeds will be used in connection with the corporation's $300,000,000 expansion program.

△ U. S. Steel presented a proposal covering a one-year extension of its present wage contract to the USW.

△ The Bureau of Mines reported that production of Pennsylvania anthracite for April, 1959 was 1,509,000 net tons compared with 1,508,000 tons in March, 1959 and 1,571,000 tons in April, 1958.

△ Roger M. Blough, chairman U. S. Steel Corp., addressing 1200 shareholders, reiterated that U. S. Steel "had no intentional desire to change the level of prices" and "U. S. Steel sees no reason why there should be further employment cost increases this year."

△ The Commerce and Labor Depts. reported that construction outlays for April, 1959 rose to $4,200,000,000, up $400,000,000 from March, 1959 and $600,000,000 over April, 1958; spending for new construction, on a seasonally adjusted annual rate, amounts to $54,300,000,000 compared to actual outlay of $49,000,000,000 for the full year, 1958.

May 6

△ Detroit Steel Corp. bought and retired an additional 21,000 shares of its 6 per cent preferred stock; of the 60,000 shares issued in 1955, 15,000 shares are currently outstanding and are held by the corporation's retirement income trust.

△ President Eisenhower urged steel contract negotiators to show "good sense and wisdom" lest they set off another inflationary surge. The industry, represented by U. S. Steel Corp., repeated its request for a year's extension of present contracts; the proposal was rejected by USW.

May 7

△ Auto sales for the final third of April amounted to 182,000 new cars, carrying the month's total sales to 502,500 cars, 2.65 per cent above the March level.

△ Federal Housing Administrator Mason predicted housing starts will total 1,285,000 both in 1959 and 1960; 1958 totals were nearly 1,200,000.

△ State highway officials appealed to Congress to provide $2,500,000,000 yearly to continue work until the interstate highway modernization program is completed, citing that 37 states will be forced to halt construction plans next year if interstate road allotments are cut down.

△ Prime grades of steelmaking scrap dropped $2 a ton in Pittsburgh; No. 1 heavy melting dealer scrap, quoted nominally in recent weeks at about $37 a ton, sold for $35.

May 8

△ The Assn. of American Railroads reported that rail freight shipments last week rose to 674,123 cars, up 26.4 per cent over the same week in 1958.

△ The Labor Dept. reported steelworker productivity fell 2.9 per cent from 1956 to 1958, revising its earlier report that the decline in output per man-hour amounted to 6.2 per cent in the period.

May 11

△ The AISI reports that the operating rate of the steel industry for the week of May 11 is scheduled at 2,665,000 tons (94.1 per cent of capacity). This compares with 2,604,000 tons one week ago (92.0 per cent capacity) and 1,412,000 tons one year ago. Index of production for the week is 165.9.

May 12

△ The AISI reports that steelmaking furnaces poured 11,272,000 net tons of ingots and steel for castings during April, 1959 (92.9 per cent capacity) compared with 11,567,745 tons in March, 1959 and 5,532,991 tons in April, 1959. Index of production for April was 163.7.

△ The Government reported that April employment totaled above 65,000,000, an increase of 1,200,000 over March; unemployment declined to 3,627,000, down 735,000 from March, 1959.

△ A plan for development of the Mount Nimba iron ore body by a joint venture of the Liberian American-Swedish Minerals Co. (Lasmco) and Bethlehem Steel Corp. has been approved by the Government of Liberia.

△ Alcoa is increasing its output rate to 82 per cent capacity; restarting two idle potlines, one at its Point Comfort, Tex., smelter, the other at Vancouver, Wash., boosting outturn by 40,000 tons annually.

May 13

△ The House Ways and Means Committee formally approved a bill extending defense contract renegotiation four years beyond June 30.

△ The Bureau of Mines reported that production of fuel briquets in the United States in 1958 totaled 1,035,261 net tons valued at $13,697,169 compared with 1,104,781 tons valued at $14,802,033 in 1957;

packaged fuel produced in 1958 amounted to 35,769 net tons at $828,116 compared to 47,287 tons at $1,022,262 in 1957.

May 14

Δ The Material Handling Institute, Inc. index shows the dollar volume of orders in March, 1959 at 146.36, compared with 124.77 in February, 1959 and 97.89 in March, 1958 (using 100 as the monthly average for the statistical base year 1954).

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in April, 1959 were $13,328,000 compared with $6,146,000 in March. New orders for induction equipment for April, 1959 totaled $1,268,000 compared with $731,000 in March, 1959.

Δ Dow-Jones industrials index increased 5.39 points, or 0.96 per cent, to a record 633.05; rails advanced 0.31 per cent to 165.14.

Δ Federal Power Commission authorized $112,300,000 of proposed construction to bring 360,000,000 cu ft of natural gas daily to the Chicago-Gary area.

May 15

Δ Gold bullion sold in London at $35.145 an ounce, up 4¢ in this month.

Δ The AAR announced that rail freight loadings last week rose to 677,398 cars, up 26.5 per cent from the same period in 1958.

May 18

Δ Output of goods and services for the quarter ended March 31, 1959 totaled $467,000,000,000 annually, $40,000,000,000 above the March 31, 1958 quarter; April, 1959 total was 149 per cent of the 1947 49 average, two points over the March, 1959 output.

Δ The AISI reports that the operating rate of the steel industry for the week of May 18 is scheduled at 2,674,000 tons (94.4 per cent of capacity). This compares with 2,631,000 tons one week ago (92.9 per cent capacity) and 1,523,000 tons one year ago. Index of production for the week is 166.5.

May 19

Δ The Labor Dept. reported that personal income in April, 1959 amounted to $372,700,000,000 annually; this exceeded the March pace by $3,200,000,000 and $23,000,000,000 over the rate in April, 1958.

Δ Fiscal report of Northwestern Steel and Wire Co. and subsidiaries indicates sales for the quarter ended April 30, 1959: $25,173,640, net income $2,634,786 or $1.05 per share, compared with sales of $15,480,180, income $1,513,313 or $0.60 per share for the same period in 1958; for the nine months period ended April 30, 1959, sales were $59,809,969, net income $5,559,854 or $2.22 per share; compared with sales of $39,521,802, income $2,789,847 or $1.11 per share for the same period of 1958.

Δ The ARCI reports that deliveries of new freight cars in April, 1959, totaled 3741 cars compared with 2797 in March, 1959 and 5163 in April, 1958. New orders for April, 1959 amounted to 3736 compared with 10,795 in March, 1959 and 278 in April, 1958. Backlog of cars on order as of May 1, 1959 was 35,479 compared with 35,487 on April 1, 1959 and 32,908 on May 1, 1958.

May 20

Δ In a speech at Brownsville, Tex., Teamsters Union president, Hoffa, threatened a nationwide strike if Congress makes labor unions subject to antitrust laws.

May 21

Δ The AFL-CIO decided to fight House passage of the Kennedy labor reform bill unless its curbs on unions are eased.

May 22

Δ The House voted 175 to 91 in favor of a four-year program of additional low-cost public housing for city dwellers, estimated to cost $2,100,000,000.

May 25

Δ The AISI reports that the operating rate of the steel industry for the week of May 25, is scheduled at 2,671,000 tons (94.3 per cent of capacity). This compares with 2,644,000 tons one week ago (93.4 per cent capacity) and 1,567,000 tons one year ago. Index of production for the week is 166.3.

Δ Koppers Co. Inc., engineering and construction division will rebuild a 60-oven battery of coke ovens at Sparrows Point for the Bethlehem Steel Co.

May 26

Δ The Aluminum Assn. reported that primary aluminum production in the United States during April, 1959, was 155,213 short tons compared with 157,189 short tons in March, 1959, and 125,000 short tons in April, 1958.

Δ According to F. W. Dodge Corp. report construction contracts in the U. S. (excluding Alaska) totaled $3,778,419,000 in April, 1959.

May 27

Δ Crucible Steel Co. of America is offering its common stockholders of record May 26, rights to subscribe at $100 per share for 99,885 shares of 5¼ per cent cumulative convertible preferred stock, par $100, at the rate of one share of preferred for each 38 shares of common stock held. Offer will expire June 9.

Δ Retail auto sales in the middle third of May averaged 20,700 daily, 5 per cent over the early May rate and 39 per cent above the same period of 1958.

Δ Steel labor negotiators broke off talks for a six-day recess after three weeks without any reported progress.

Δ A Federal judge at Duluth, Minn., upheld Reserve Mining Co. in efforts to require Mesabi Iron Co. to resume arbitration of questions regarding accounting and royalty payments.

Δ AISC reported that bookings of fabricated steel in April, 1959, totaled 294,806 tons, compared with 254,773 tons in March, 1959 and 208,161 tons in April, 1958. Shipments in April, 1959 totaled 290,623 tons, compared with 260,490 tons in March, 1959 and 323,574 tons in April, 1958. Backlog of future work on April 30 amounted to 1,921,929 tons.

May 29

Δ Five Federal Reserve Banks, in New York, Chicago, St. Louis, Minneapolis, and Dallas, increased discount rates to member banks ½ per cent to 3½ per cent.

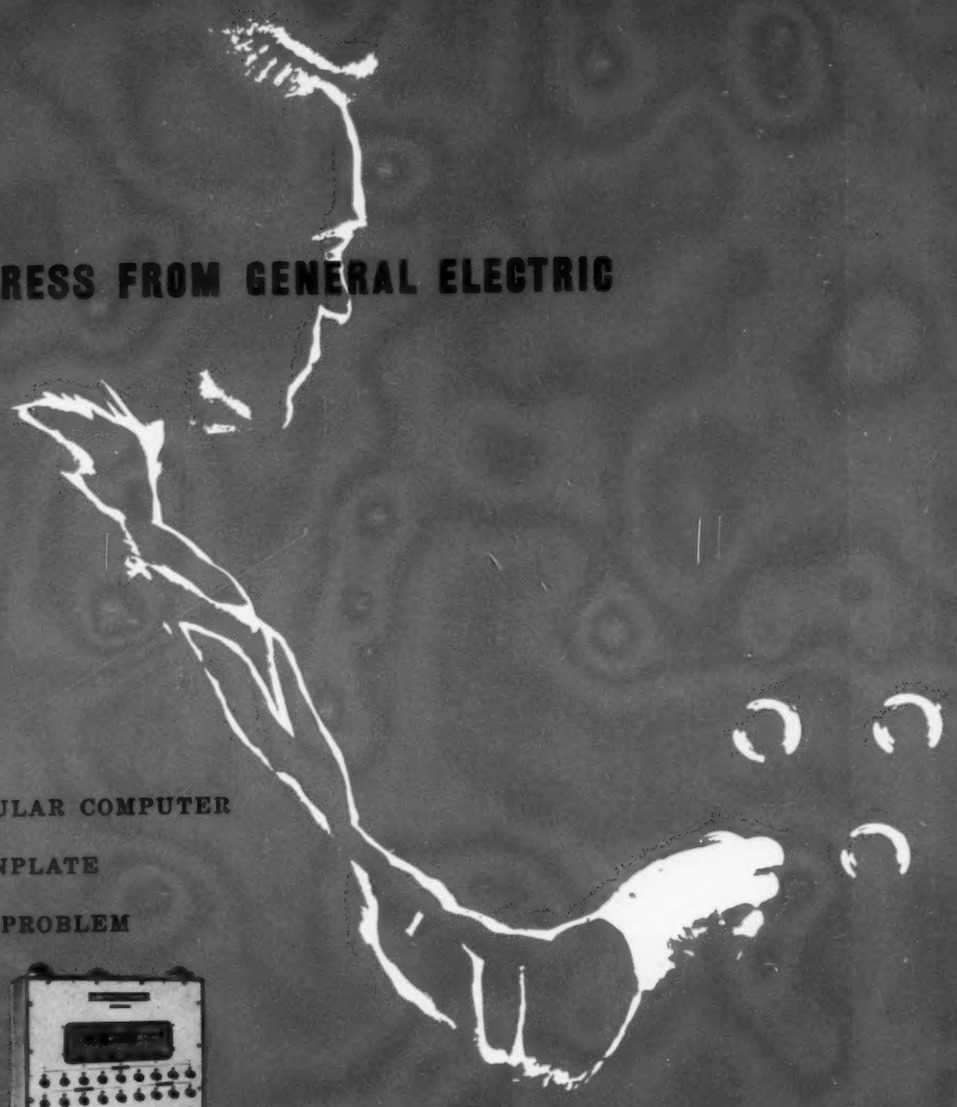
May 30

Δ Auto dealers inventories of new cars total over 910,000 U. S. built models (including foreign cars the total is around 1,000,000 units) compared with stocks of U. S.-made cars totaling 755,000 a year ago.

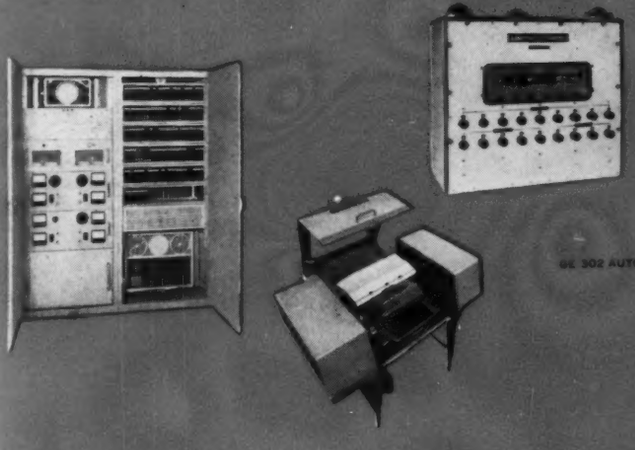
Δ Armco Steel Corp. announced a $17,000,000 expansion program for stainless steel production facilities at its Butler, Pa., works, scheduled for completion late in 1960, for the production of wider stainless steel sheets and coils at closer tolerances.

Δ The British Iron and Steel Board reduced prices of steel 2 per cent, or about $2.80 a ton, on orders running to 10 tons or more. The reduction is regarded as essentially a long-term measure and not just an attempt to increase the current rate of about 81 per cent of capacity.

COMPUTER PROGRESS FROM GENERAL ELECTRIC



CUSTOM DESIGNING MODULAR COMPUTER COMPONENTS TO SOLVE A TINPLATE INSPECTION AND BILLING PROBLEM



GE 302 AUTOMATIC INSPECTION DATA ACCUMULATOR

The trend toward purchase of tinplate direct in large coils rather than sheets placed an unusually difficult inspection and billing problem upon manufacturers.

The G-E 302 Automatic Inspection Data Accumulator – custom-designed by the Computer Department – solves this problem by electronically accumulating and tallying data from inspection sensors in a new solid-state system. The system is fully automatic ... provides a complete type-written record for quality control and billing purposes immediately upon completion of each coil.

Request brochure CPB-14B. Contact your nearest General Electric Apparatus Sales Division Office, or write to: Computer Department, Room 4400A General Electric Company • Deer Valley Park • Phoenix, Arizona

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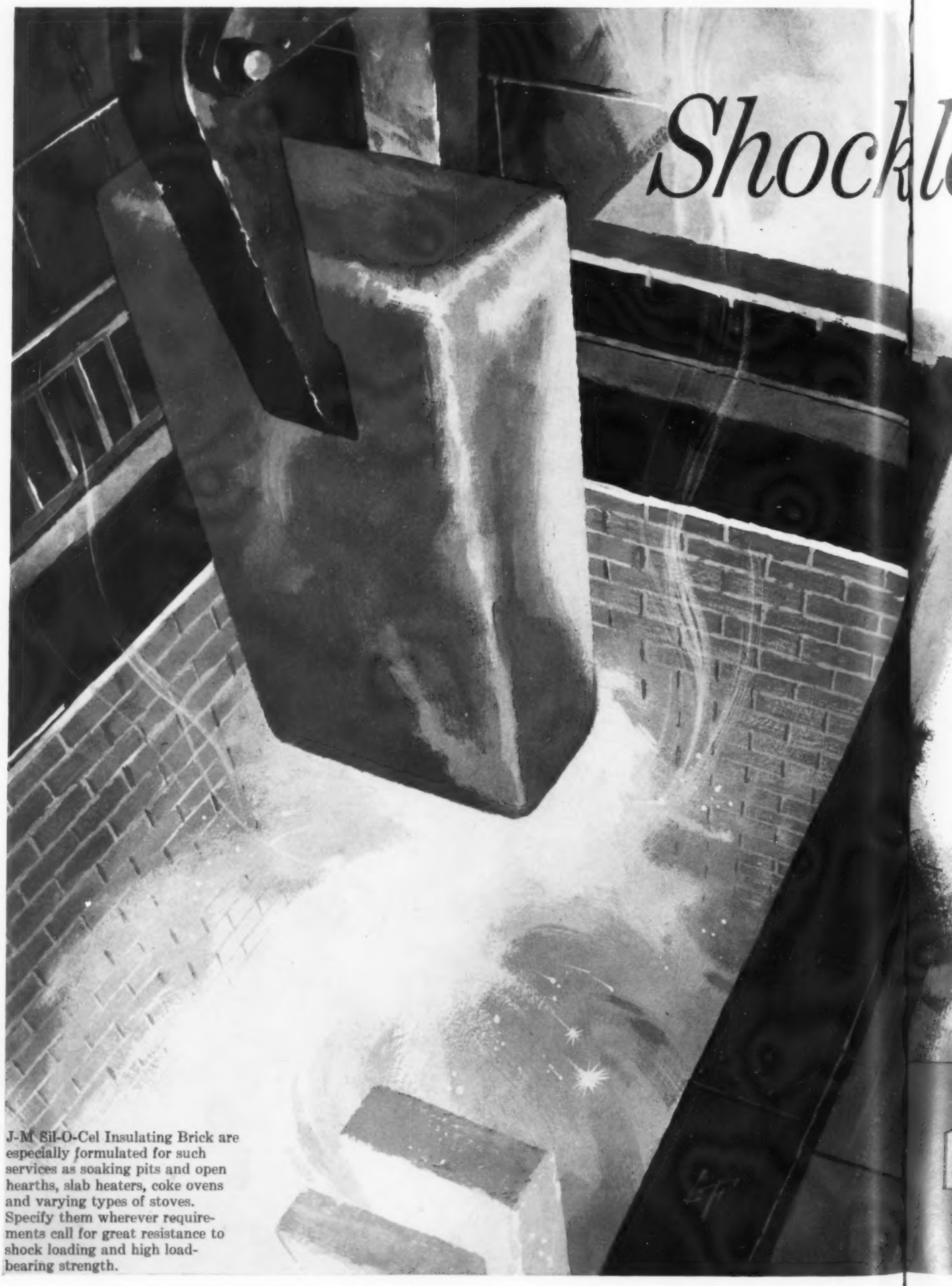
FOR FIGURES IN A HURRY—FIGURE ON A GE COMPUTER

CPB-14 (4-59)



J-M Sil-O-Cel Insulating Brick are especially formulated for such services as soaking pits and open hearths, slab heaters, coke ovens and varying types of stoves. Specify them wherever requirements call for great resistance to shock loading and high load-bearing strength.

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call for Johns-Manville Sil-O-Cel Insulating Brick!

Hot blast stove walls, open hearths, soaking pit bottoms—the unexcelled performance of J-M Sil-O-Cel® brick in rugged services like these explains their wide acceptance. Today, they are used as back-up insulation by virtually every major equipment builder.

Made of heat-resistant diatomaceous silica, Sil-O-Cel Insulating Brick are produced in three load-bearing types: Sil-O-Cel *Super* (to 2500F) and Sil-O-Cel *C-22* (to 2000F) for peak performance and long life under extremes of heat, weight and shock. Sil-O-Cel *16L* combines performance and economy for lower temperatures to 1600F.

To bring you the right brick for your needs, Johns-Manville *also* offers six Insulating Fire Brick types. This wide selection of Insulating Fire Brick lets you choose the *one* brick that gives you the most favorable combination of temperature resistance, strength, conductivity, density and cost.

Write today for your copy of IN-115A, 8-page booklet on Johns-Manville Insulating Fire Brick. It gives complete physical and thermal properties of each type, along with sizes and shapes available. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

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JM-3000	JM-28	JM-26	JM-23	JM-20	JM-1620	Sil-O-Cel® Super	Sil-O-Cel C-22	Sil-O-Cel 16L
service to 3000F	service to 2800F	service to 2600F	service to 2300F	service to 2000F	to 1600F exposed; to 2000F back-up	to 2500F back-up	to 2000F back-up	to 1600F exposed or back-up

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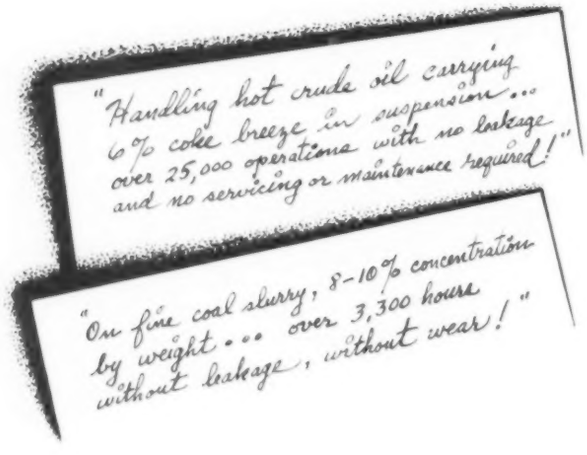
LOOK AT THESE PERFORMANCE RECORDS WITH DeZURIK VALVES!


"Handling hot crude oil carrying 6% coke breeze in suspension... over 25,000 operations with no leakage and no servicing or maintenance required!"
"On fine coal slurry, 8-10% concentration by weight... over 3,300 hours without leakage, without wear!"

Isolated cases? Not a bit! DeZurik Valves turn in an enviable performance in every plant in which they're installed. No other valve can touch them, because no other valve is *made* with Eccentric Action. They need no lubrication because the plug touches the valve body ONLY when the valve is closed. And they shut tight with the cushioned closure of a resilient plug facing.

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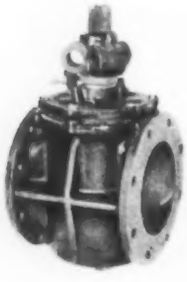

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Many styles and sizes for metal marking. Letters, numbers or symbols on either or both ends; interchangeable type heads available.

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8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill

Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

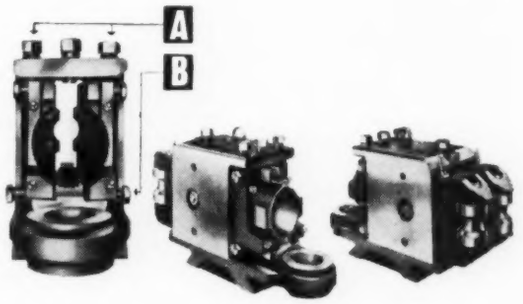
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

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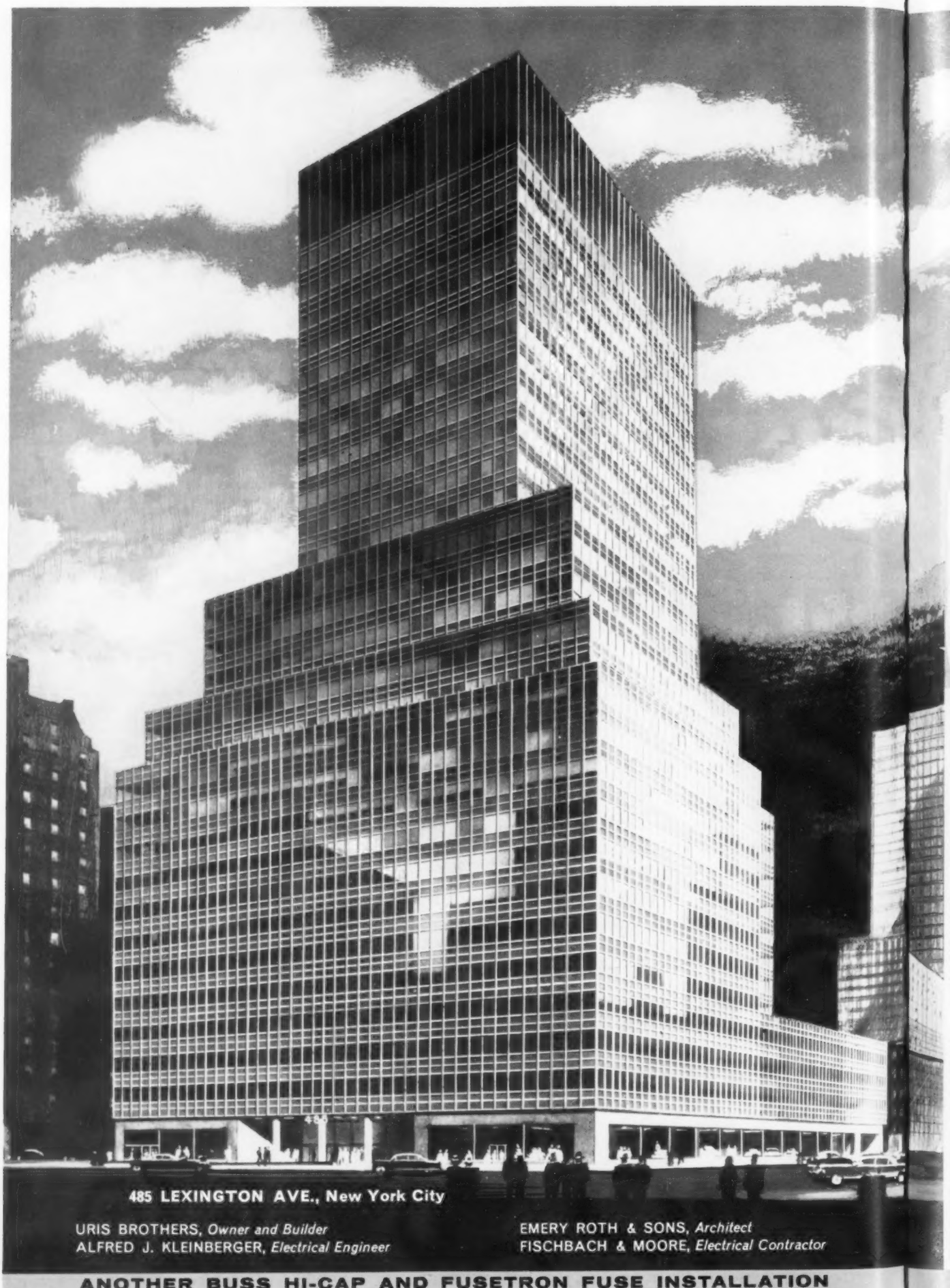

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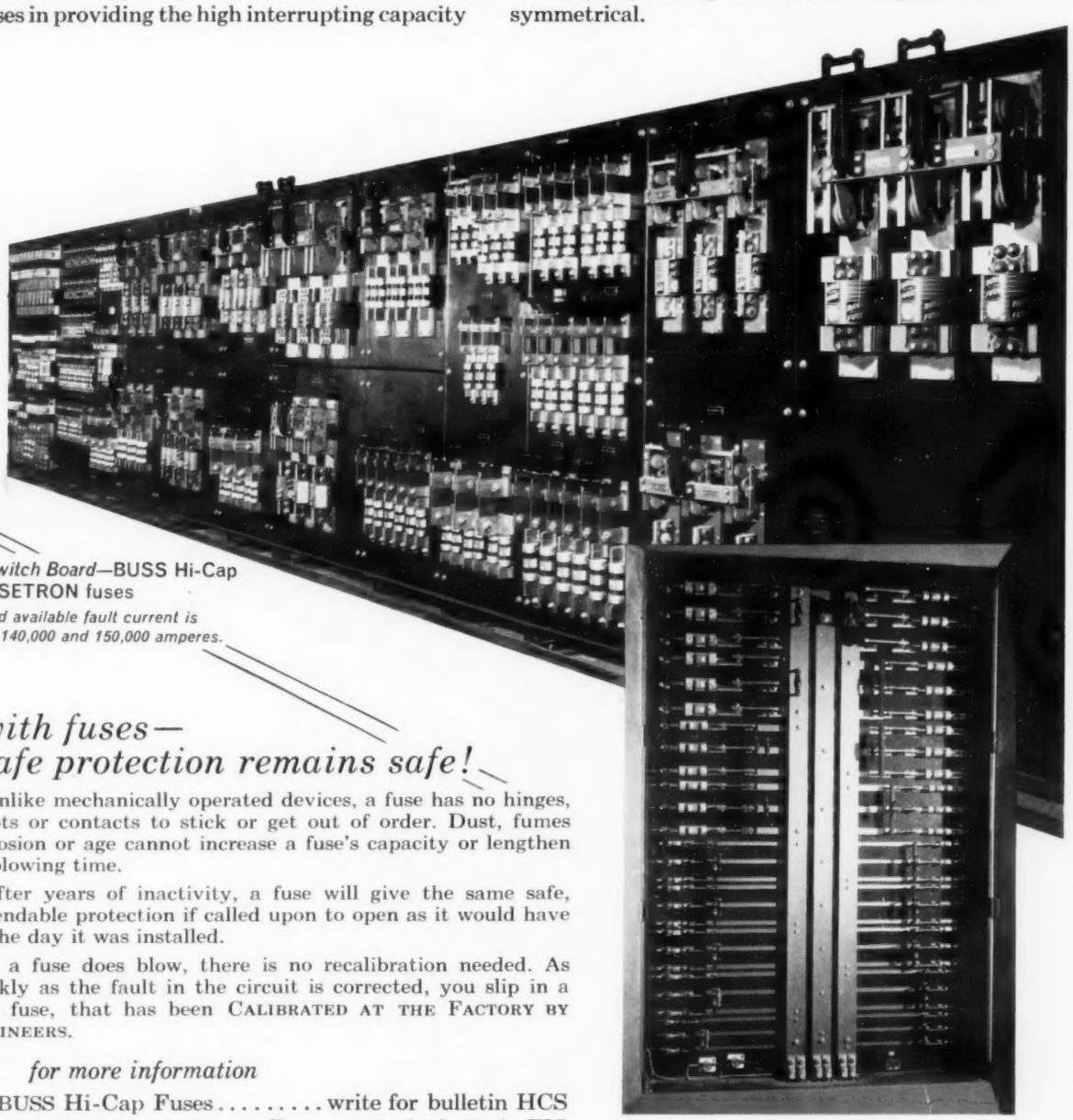
Electrical Protection goes MODERN *with* BUSS Fuses at 485 Lexington Ave., New York, N.Y.

In keeping with the modern trend the electrical protection for this new 30 story office building is BUSS Hi-Cap and FUSETRON dual-element fuses.

No other type of protective device can match fuses in providing the high interrupting capacity and dependability required for today's circuits.

BUSS Hi-Cap fuses have a NEMA interrupting rating of 200,000 amperes rms symmetrical. FUSETRON dual-element fuses have a NEMA interrupting rating of 100,000 amperes rms symmetrical.



Main Switch Board—BUSS Hi-Cap *and* FUSETRON fuses

Estimated available fault current is between 140,000 and 150,000 amperes.

with fuses— safe protection remains safe!

Unlike mechanically operated devices, a fuse has no hinges, pivots or contacts to stick or get out of order. Dust, fumes corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

After years of inactivity, a fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

If a fuse does blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse, that has been CALIBRATED AT THE FACTORY BY ENGINEERS.

for more information

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On FUSETRON dual-element Fuses..write for bulletin FIS

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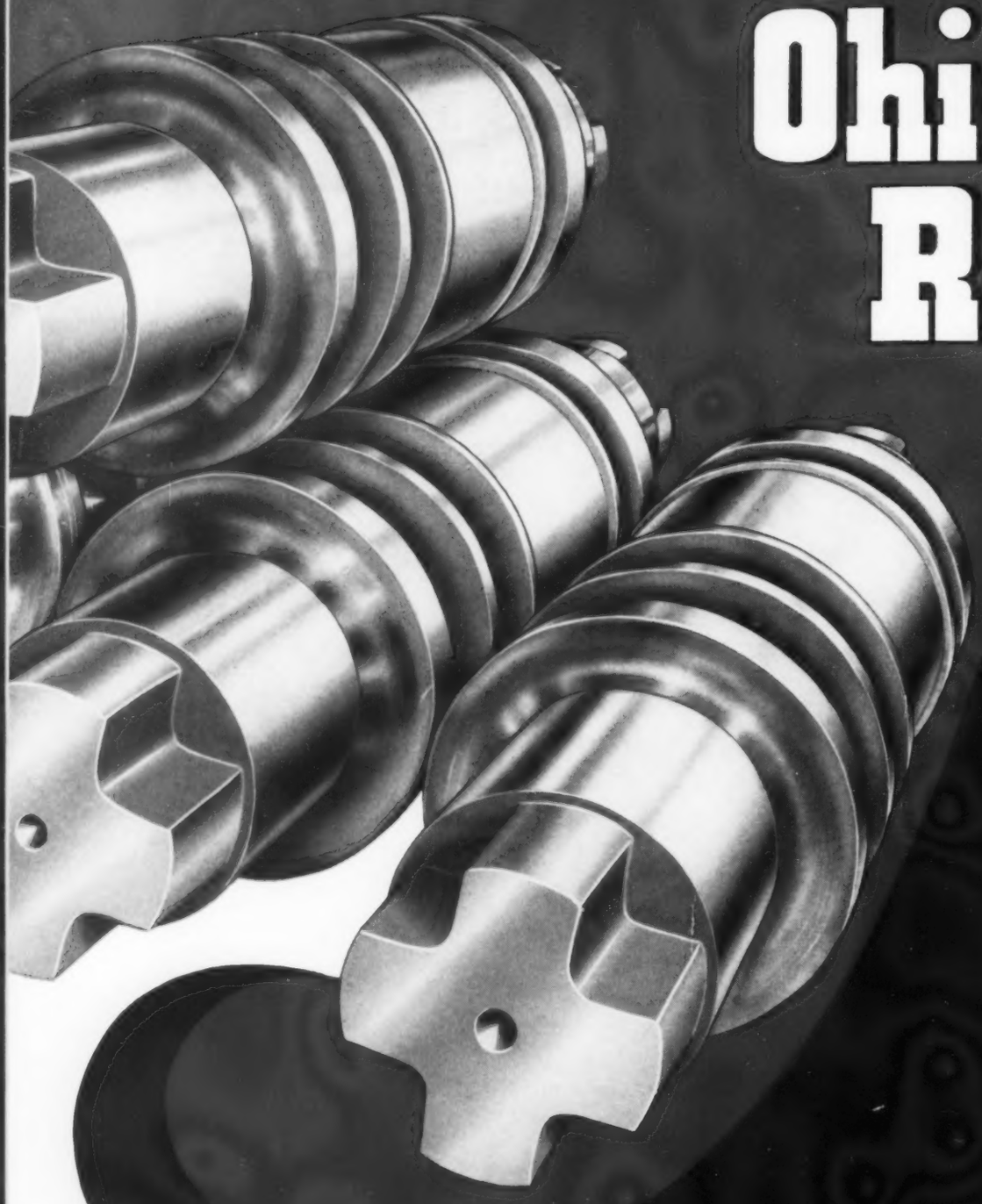
Ohio Rolls



OHIO
IRON AND STEEL
ROLLS

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OHIOLOY ROLLS
OHIOLOY "K" ROLLS
FLINTUFF ROLLS
DOUBLE-POUR ROLLS
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OR27

Industry News...

J&L TO BUILD BLAST FURNACE AND TWO BASIC OXYGEN FURNACES AT CLEVELAND WORKS

△ Construction on the two largest basic oxygen furnaces in the world and one of the largest blast furnaces in the United States will be started at the Cleveland Works of Jones & Laughlin Steel Corp. this summer, it was announced by J. R. Powell, manager of the Cleveland Works.

The new basic oxygen furnaces are expected to produce 160-ton-heats—larger than J&L's two other basic oxygen furnaces at the Aliquippa Works, which are currently making 81-ton heats. The Aliquippa furnaces have been producing at the rate of 106 tons per hour.

The new blast furnace, to be constructed in the immediate vicinity of the Works' two other blast furnaces, will have the largest hearth diameter and the largest working volume in the United States. The 110-ft-high furnace will have a diameter of 32 ft and a working volume of 65,000 cu ft. It will have a daily rated capacity of 2500 tons and will increase the yearly rated iron capacity at the Cleveland Works from 866,000 to 1,800,000 tons.

The basic oxygen furnaces, which will have a total annual rated capacity of 1,200,000 tons, will be constructed adjacent to eight 175-ton stationary open hearth furnaces, which are to be deactivated and partially dismantled. The eight furnaces were constructed in 1924 when the Cleveland Works was the Otis Steel Co.

Three 220-ton stationary open hearth furnaces will remain in operation, as well as two new large electric arc furnaces, thereby enabling the Works to produce steel by three of the most modern methods. The open hearth furnaces have a yearly-rated capacity of 720,000 tons of steel. The three furnaces already have been equipped with oxygen lances and basic roofs to increase both quality of product and speed of production, and will now be equipped with precipitators for smoke control.

Mr. Powell said the new program will mean that all steelmaking facilities in regular use at the Cleveland Works will incorporate all of the latest developments for air pollution abatement control. Upon completion of the current program, approximately $10 million will have been expended since 1957 in projects of this nature.

These include electrostatic precipitators for the basic oxygen furnaces, the three open hearth furnaces remaining in operation, and the two electric furnaces, an orifice scrubber for the new blast furnace, and the recently-installed blast furnace slag pit.

In the operation of the electrostatic precipitators on the basic oxygen furnaces, gases will be drawn into water-cooled hoods directly above the furnaces. The gases then will be sprayed with water to remove the heavier material and to cool them. The electrostatic precipitators then will remove the fine dust.

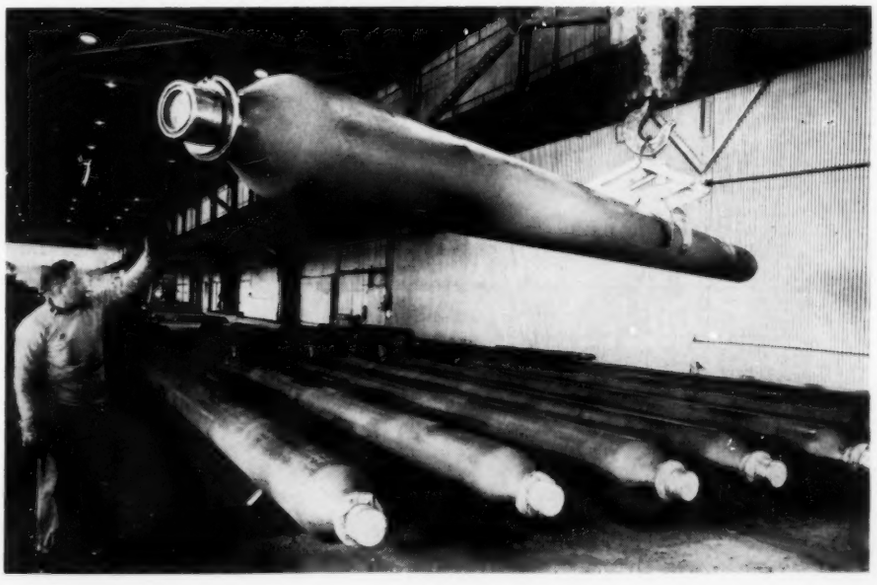
The gas orifice scrubber for the blast furnace, which was developed by J&L engineers, cleans the gases from the furnace and prevents their being released into the atmosphere. In the system, the gases are cleaned by means of atomization of water brought about by excessive turbulence of the gases passing through a restriction in the gas line.

Other recent improvements at the Cleveland Works include the installation of a new reversing rougher on the 77-in. hot strip mill, a new high-lift blooming mill, a 56-in. temper mill, a new four-stand cold reducing mill, a sintering plant, electric furnaces, additional soaking pits, and numerous other finishing facilities.

HELIUM CYLINDERS BACK IN PRODUCTION

Helium, which now has assumed an important role in the missile field, has prompted the production of an old and familiar item at the Christy Park Works of U. S. Steel Corp.'s National Tube Division.

High quality steel cylinders, used to transport helium over the nation's railroads, are being produced for the American Car & Foundry Division of A. C. F. Industries, Inc. Thirty of the vessels will be fitted on each helium transport car. Each cylinder will be 18 in. in diameter and 33 ft long, and will be fabricated from seamless steel pipe. The pipe will be made of manganese molybdenum alloy steel. Helium is used as a backup gas for liquid oxygen and other missile fuels. Under high pressure, it forces these fuels into the missile's engine and, because it is an inert gas, does not affect these fuels. This is an important consideration, since fuel must be metered into missile engines in precise quantities to meet programmed flight specifications.



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CIRCLE ROLLS
for every purpose

Uniform performance, high production and long service are unfailing characteristics of these better rolls.

Preferred by leading mills throughout the nation for more than half a century.

Yes, there's a Red Circle Roll for every purpose.

ROLLS

Nickel Alloy Grain Rolls
Grain Rolls
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Nickel Chilled Rolls
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Nodular Iron Rolls

All Grades Nickel Alloy Iron Rolls for Hot and Cold Rolling

Hyde Park
FOUNDRY and MACHINE CO.
HYDE PARK
Westmoreland County, Pa.

Rolls
Rolling Mill Equipment
Gray Iron Castings

NEW SENDZIMIR MILL OPERATING AT CUYAHOGA

△ A 37-in. Sendzimir mill, capable of turning out stainless steel strip in ultra-thin gages at close tolerances has been put into production at the Cuyahoga Works of United States Steel Corp.'s American Steel & Wire Division.

The new mill at Cuyahoga is equipped with the very latest in beta-gamma ray gages and controls to assure correct thickness without variation throughout an entire coil of stainless steel.

The new mill has two primary backup rolls plus three secondary backup rolls and four backup bearing shafts for each work roll. These give the driving power and exert closely controlled pressure on each of two work rolls. The dressing for all of these rolls must be kept within the strictest tolerance in order for the mill to function properly. During operations the entire working area, including the work rolls, the backup rolls and the strip itself is continuously lubricated by a constant flow of filtered mineral oil.

Along with the new mill, there has been a modernization and expansion of certain stainless steel working facilities at the plant. Included are improvement to the welding line, modernization of the annealing and pickling lines, and the inclusion of a scouring line to assure a faultless finish on the product to be shipped.

The new facility will accept strip up to 0.175 in. thick and roll it down to 0.005 in. During the process, after any reduction of more than 50 per cent the metal is annealed to relieve work hardening before further rolling.

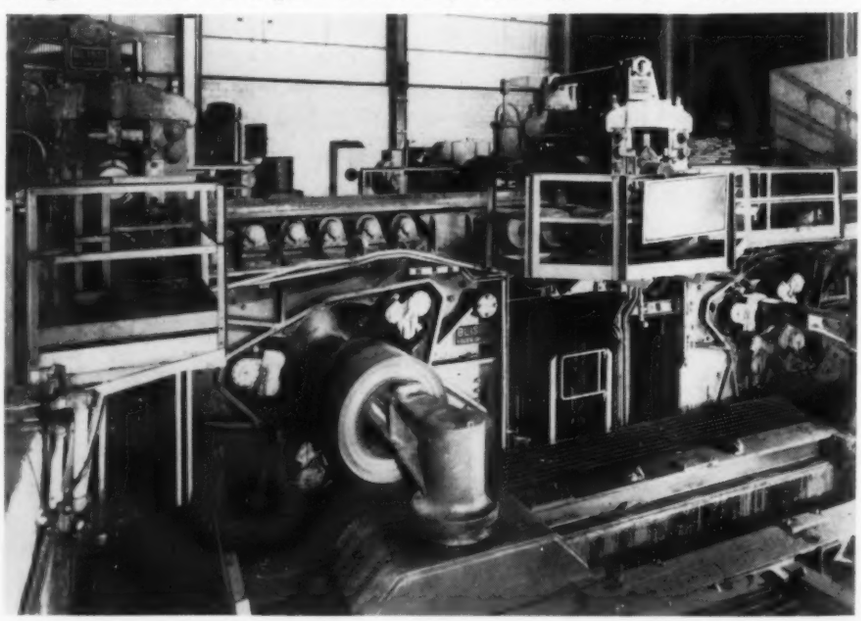
It is also during the rolling process that the scouring line is brought into play. This line is made up of an arrangement of rolls and abrasive paper which polishes the total surface of the strip. A further precaution is the use of a continuous roll of interleaving paper between each layer of stainless steel strip as it is coiled.

Power to drive the mill is supplied by three 1000-hp motors. The rated top producing speed for the mill is five hundred fpm.

The precise controls on the mill utilize the latest in radio-active precision gages. These are non-contact gages and continuously measure the thickness of the steel passing through the mill. To do this, a radio-active source is used to emit beta rays. Some of these beta rays are

DOWNCOILERS HANDLE MILD STEEL TO STAINLESS

Designed to handle a wide variety of gages and tempers, these E. W. Bliss Co. downcoilers are installed on Armco Steel Corp.'s new 56-in. hot strip mill at Butler, Pa. The downcoilers maintain a constant tension on the strip and provide a positive wrapping action on their expanding mandrels. Blocker rolls retract as soon as the leading end of the coil has been snubbed on the mandrel, insuring mark-free surfaces during the coiling operation. The blocker rolls do not move in again until the trailing end of the strip is passing through the pinch rolls.



QUALITY KNIVES FROM
HEPPENSTALL

HEPPENSTALL COMPANY
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PLANTS: Pittsburgh, Pa. • Bridgeport, Conn.
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MIDVALE-HEPPENSTALL COMPANY
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DIE BLOCKS • FORGINGS • BACK-UP ROLL SLEEVES • RINGS • INDUSTRIAL KNIVES • MATERIALS HANDLING EQUIPMENT

Every Heppenstall knife is tested for hardness to determine the relative resistance to indentation or displacement of the metal by pressure.

PITTSBURGH BICENTENNIAL 1758-1958

BROOKS OIL CO.
SALUTES . . . .

THE FIRST OIL WELL in The UNITED STATES was located on Oil Creek at Titusville in Pennsylvania. Colonel E. L. Drake began work on this well May 20, 1859, and on August 27 of the same year struck oil at a depth of 69½ feet. The well produced thirty barrels a day for a year.

THE 100TH ANNIVERSARY OF THE OIL INDUSTRY

and 17 years later 1876 Brooks Oil Co.

began production of kerosene for lamps to light American homes and grease for wheels and axles of Conestoga wagons. In serving industry for 83 years, the Brooks Oil Company has established an outstanding reputation for providing lubricants of the highest quality throughout the world. Today our plant, laboratory, engineering and research facilities are among the most modern and efficient in this highly specialized lubrication field. Supplying SUPERIOR LUBRICANTS for today's highly specialized industry is our specialty.

LEADOLENE
KLINGFAST
BARCOTE
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The BROOKS OIL Company
Established 1876

General offices and U.S. plant: 3304 East 87th Street • Cleveland 27, Ohio
Canadian offices and plant: 461 Cumberland Avenue, Hamilton, Ontario
Warehouses in Principal Industrial Cities

used to measure strip in the 0.005 to 0.028 in. range. Other beta rays, from the same source, are converted into gamma rays which are used to measure strip in the 0.028 in. to 0.175 in. ranges.

NEW FIRM NAMED AGENT FOR BEDFORD FOUNDRY

△ Charles F. Simmers has recently established his firm, C. F. Simmers, Inc., Canfield, Ohio. The company will engineer industrial, steel mill and special cranes, rolling mill machinery, automation, material handling and welded fabrications. The firm will represent the Bedford Foundry and Machine Co. in the tri-state area, and will also serve them as consulting engineer on cranes.

Complete engineering on the majority of steel mill cranes meeting AISE specifications, sold by Bedford, will be engineered in Canfield under their supervision.

McLOUTH STEEL TO ADD SIXTH BASIC OXYGEN UNIT

△ Pennsylvania Engineering Corp. has received an order for another basic oxygen furnace for the Trenton, Mich., plant of McLouth Steel Corp. This sixth Pecor-built installation at McLouth is expected to give this steelmaker the largest basic oxygen steel capacity in this country.

The new furnace will have a nominal capacity of 110-tons per heat, and is scheduled for operation late this year. Previous installations at McLouth include two 80-ton and three 35-ton basic oxygen furnaces.

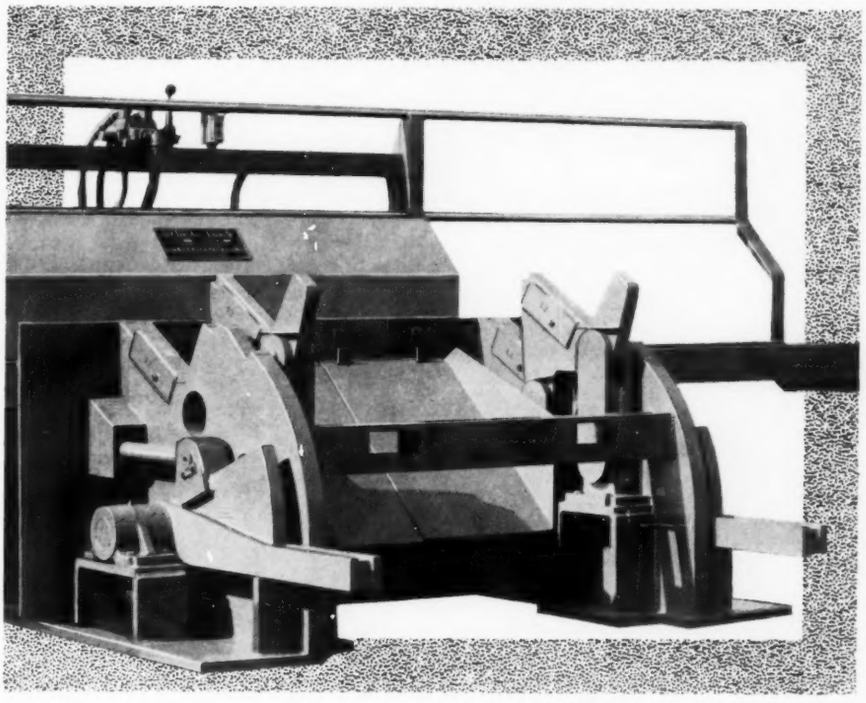
The current order also calls for a post crane to handle the smoke hood and oxygen lance, and several other pieces of auxiliary equipment.

MESTA TO FURNISH COLD MILL FOR BRAZIL PLANT

△ The Mesta Machine Co. is furnishing a 56-in. four-high three-stand tandem cold mill for the Volta Redonda Plant of Companhia Siderurgica Nacional of Brazil. Equipment furnished includes three cold mill stands in tandem, coil entry ramp with coil stops, coil box, entry pinch rolls, tension reel of the over-

Slabs, Bars, Billets and Blooms conditioned faster, safer, more economically with special

TURNING DEVICES BY EVANS



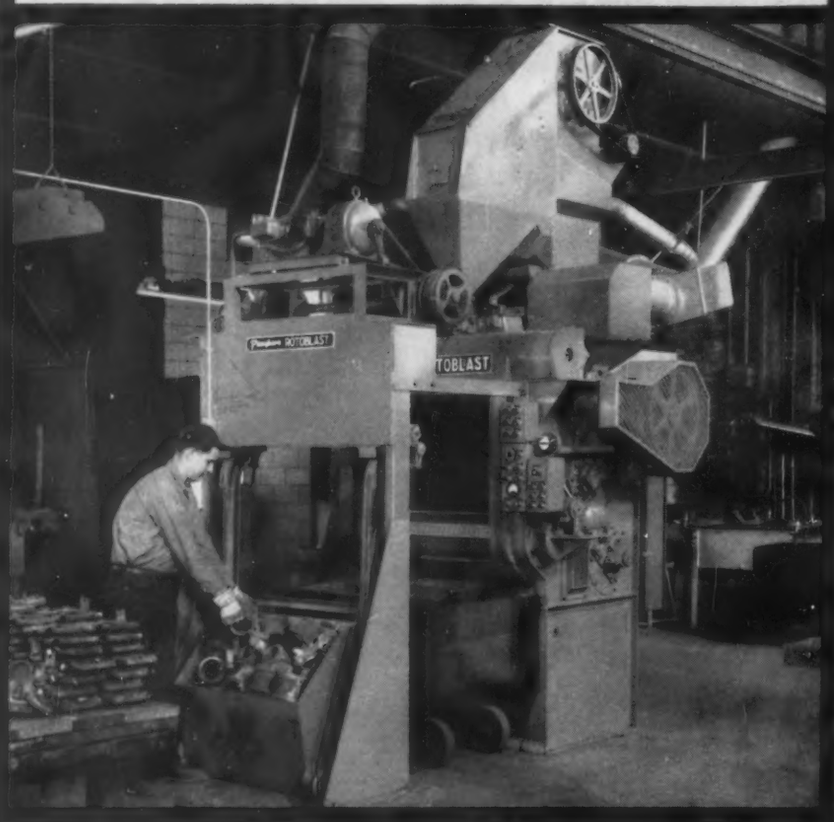
- mechanized inspection tables for efficient inspecting or scarfing of round or square bars and billets.
- mechanical and hydraulic bloom and billet turners engineered to fit specific requirements and shop conditions.
- new mechanical slab and billet turner to speed the manipulation of slabs and billets for increased production and reduced handling time.

And along with Evans Turning Devices you get qualified engineering assistance in the development and selection of effective feed mechanisms and supplementary materials handling equipment.

Write today for the new Evans descriptive two-color brochure

EVANS ENTERPRISES INCORPORATED
MASSILLON, OHIO

ROTOBLAST CUTS CLEANING TIME 70%!



Pangborn Rotoblast reduces cleaning time from 15 minutes per load to 4½ minutes at Buckeye Iron & Brass

To reduce costs and still keep up production schedules, Buckeye Iron & Brass Works, Dayton, Ohio, replaced its centrifugal blast cleaning barrel (which is still in good operating condition) with an automated 6′ Pangborn Rotoblast Barrel. The result: cleaning time was cut from 15 minutes per load to 4½ minutes!

Through automation, the Rotoblast Barrel has also saved the company the cost of one full-time operator and has proved economical in terms of maintenance. In seven months, no repairs or replacements, other than vanes, have been necessary!

For full details on how Pangborn Rotoblast can save you money, write for Bulletin 706 to PANGBORN CORPORATION, 4000 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment—Rotoblast Steel Shot and Grit*

Pangborn CLEANS IT FAST WITH **ROTOBLAST®**

hung mandrel type with belt wrapper, coil delivery conveyor, and coil upender.

The mill will be capable of cold reducing hot rolled and pickled strip up to 48 in. wide and 0.125 in. thick at speeds up to 2610 fpm in coils weighing up to 30,000 lb.

Mesta is also providing designs for electrical field construction, piping and foundations.

KOPPERS TO REBUILD 60-OVEN COKE BATTERY

△ Bethlehem Steel Corp. has awarded the Engineering and Construction Division of Koppers Co., Inc. a contract for rebuilding a 60-oven battery of coke ovens at its Sparrows Point, Md., plant.

An existing battery of 61 ovens, built in 1929, will be torn down to the foundations and the new battery of Koppers Gas Gun type ovens erected. Engineering work for the new ovens already has started and work at the contract site is expected to begin about July 1. The complete rebuilding is expected to take about nine months.

KAISER PLANS MAGNESIA PLANT IN MICHIGAN

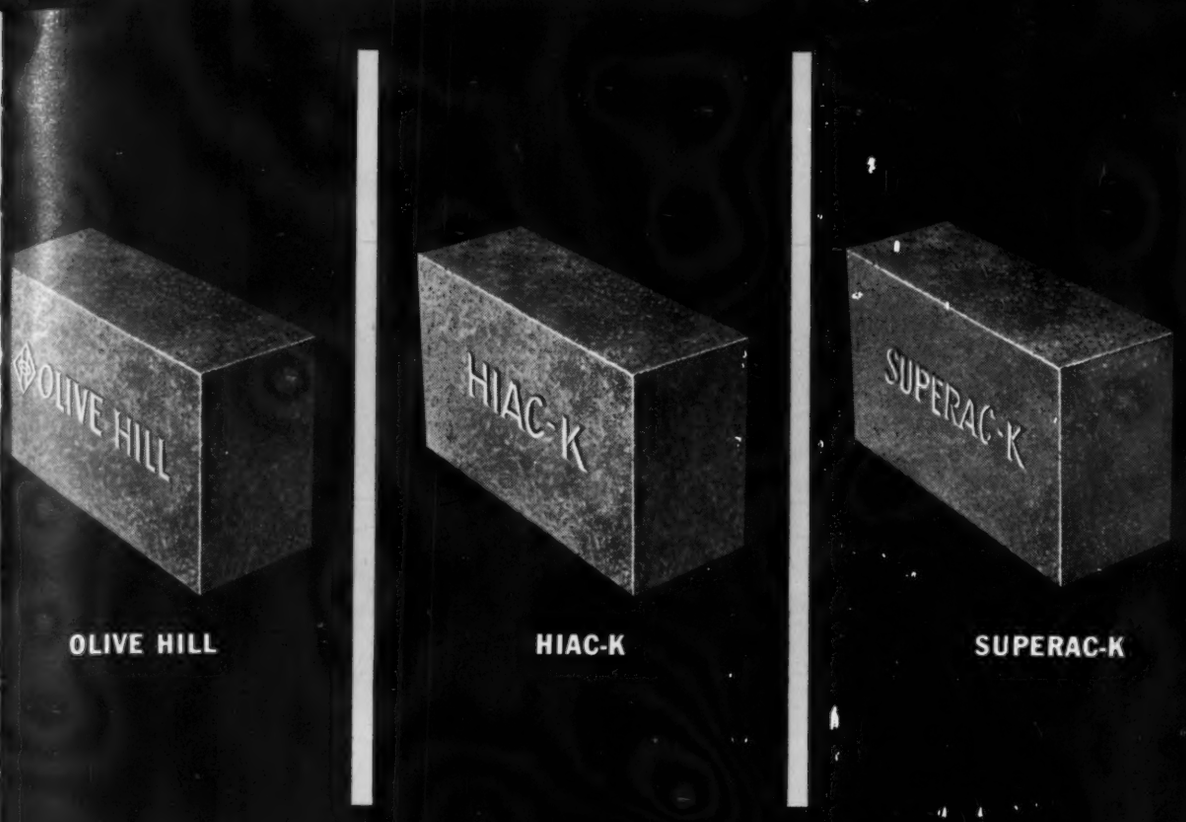
△ Kaiser Aluminum & Chemical Corp. has announced plans for a major expansion of its refractory magnesia operations by constructing a new plant at Midland, Mich.

The plant's principal product will be extremely high-purity periclase, a dense, crystalline magnesia produced and sold by the Kaiser Chemicals Division for use in basic refractories. Other special magnesia-containing refractory grains will also be produced.

The initial construction step, estimated to cost about $3,000,000, will start within the next two months. The plant will use magnesium hydroxide supplied by the Dow Chemical Co. from deep-well brine operations at Midland. Production is scheduled to begin early in 1960.

The new facilities will provide raw material to Kaiser Chemicals' Columbiana, Ohio, basic refractories plant, which is now being expanded for the second time to meet the increased demand for its products in the midwest and eastern markets.

The new Midland plant will have



OLIVE HILL

HIAC-K

SUPERAC-K

GENERAL REFRACTORIES

50 YEARS EXPERIENCE STAND BEHIND

GREFCO'S "BIG 3" STOVE BRICK!

For 50 years, General Refractories blast furnace stove brick have met the continuously tougher demands of American steelmaking. Here are today's "Big 3" in the GREFCO stove brick line, each made from the finest raw materials, under rigid quality control:

OLIVE HILL *Stove Wall Brick and* OLIVE HILL *Stove Checkers:* Preferred in hundreds of blast furnace stoves where high duty standard or multihole designs are used. Literally "a benchmark of the industry."

HIAC-K *Stove Wall Brick and* HIAC-K *Stove Checkers:* These super duty brick, standard or multihole, are made from specially calcined high-purity Georgia Kaolin, to provide low porosity and high density and refractoriness against severe service conditions.

SUPERAC-K *Stove Wall Brick and* SUPERAC-K *Stove Checkers:* Designed to withstand the most extreme destructive conditions of modern blast furnace stoves, Superac-K are the latest improvements in high fired, superduty fireclay brick. Their exceptional purity, strength and refractoriness, coupled with unusually low porosity, make them highly resistant to prolonged temperature and alkali attack.

GREFCO manufactures a complete line of multihole and special stove checker designs in each of these leading brands. Your GREFCO representative welcomes the chance to talk to you about the particular GREFCO brick best suited to conditions in your blast furnace stoves. Call him.

GENERAL REFRACTORIES COMPANY

PHILADELPHIA 2, Pa.

A COMPLETE REFRACTORIES SERVICE

"A drop in the bucket!" The constructions shown here by Tom Weichel, Okonite's portable cable engineer, are just a random sampling of the flexible cords and cables that Okonite has developed for industrial operations. More than likely, Okonite has available right now the exact cable you need—in terms of toughness, flexibility, capacity, resistance to oils, acids, alkalies, water, heat and abrasion. If not . . . we know how to build it!

Here's how we add value to your portable cable dollar

Behind these cable constructions are service records that prove the extra long life of Okocord flexible cords and portable cables under the most severe industrial conditions of mechanical abuse, run-overs, heat, oil, moisture, and constant dragging over cement floors.

Longer cable life means lower operating costs . . . reduction of costly work stoppages . . . greater utilization of expensive equipment. Truly, Okocord's longer life represents money in the pocket for any plant operator.

Here's how Okonite assures maximum value for your cable dollar.

1. By the use of materials developed in 80 years of making the finest cables.
2. By constant research to find even better materials and constructions.
3. By intimate, first-hand knowledge of industrial problems and conditions.
4. By self-imposed standards for manufacturing and testing that are more exacting than the industry requires.

There are Okocord quality cables for your machinery and portable equipment. There are Okonite specialists ready and willing to help you in the planning or installation stages. And there is a brand new booklet full of valuable hints on picking the right cable constructions for your all-important power or control circuits. Write for free Bulletin IS- 1117—"How to choose insulated cable"—to The Okonite Company, Passaic, New Jersey.

where there's electrical power . . . there's **OKONITE CABLE**

6238

an initial capacity of 45,000 tons of periclase per year, increasing the company's total annual capacity to produce magnesia furnace grains to 165,000 tons.

The facilities will be located on a 40-acre parcel of land southeast of the Dow headquarters plant in Midland. The plant will be served by the Chesapeake & Ohio railroad. It will have access to Great Lakes water transportation at nearby Bay City on Lake Huron.

TO SUPPLY DATA SYSTEM FOR TIN PLATE FACILITY

△ Westinghouse Electric Corp.'s systems control department has received an order from a major producer of steel for a Prodac Data Accumulation System for tinplate production.

Purpose of the system is to process, store and print out on continuous cards specific data that will provide an accurate, permanent record of all material included in tin-plated coils. Information to be logged includes total number of coil feet, total number of quality feet and total number of defective feet. Data on defective material will be subdivided to cover under- and over-gage material, light and heavy plating, pin hole detection and results of visual inspection.

The accumulation system will use the same static transistorized circuitry developed and used in previous Prodac installations. Similar systems are being developed by Westinghouse for other process-line and main-drive applications in the metals industry.

INTERLAKE TO BUILD CHICAGO SINTER PLANT

△ Interlake Iron Corp. announced plans to build a 3000-ton sintering plant at its Chicago, Ill., merchant pig iron producing facilities.

Designed to produce self-fluxing sinter, the plant will process iron ores, coke, flue dust and limestone into a premixed charge for Interlake's two Chicago blast furnaces.

When the new plant's design capacity of 3000 gross tons a day is reached, self-fluxing sinter is expected to comprise between 80 and 90 per cent of the total Chicago blast furnace burden. Nonsinter portions of the charge will be used to make up the required metallurgical properties of the various specifications of pig iron produced.

Construction crews of Dravo Corp., design engineer and general contractor, are expected to break ground for the plant this August. Completion is scheduled for September, 1960.

The sintering facility will be located on the east side of the Calumet River, close to the blast furnace locations. It will receive iron ore by conveyor from a new ore yard, completed last year as part of a previous modernization of Chicago facilities. Coke, which provides the fuel for the sintering process, will be fed directly into the plant from a new screening station, also completed last year.

Design features of the plant include provision for a hearth layer to extend the life of the sintering machine grates, and automatic ratio control to proportion the coke to the other materials in the sinter machine feed. Instrumentation will be centralized in a pressurized control room.

SAVE downtime for bearing replacement

use A·B·K* bearings

A-B-K bearings won't peen, score or heat check your heavy roll and spindle parts, sharply reduce downtime and maintenance costs per ton rolled. Made of laminated phenolic fabric, they have the ability to absorb and cushion heavier impacts—and often outwear metal bearings many times. When replacements *are* necessary, downtime is reduced because A-B-K bearings have fewer parts, are lighter in weight, easier to handle. Ask our engineers for specific recommendations.

- Wear longer
- Won't score
- Light in weight
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NEW TAYLOR ELECTRO-PNEUMATIC VALVE POSITIONER

Couples advanced electronic control with smooth pneumatic action

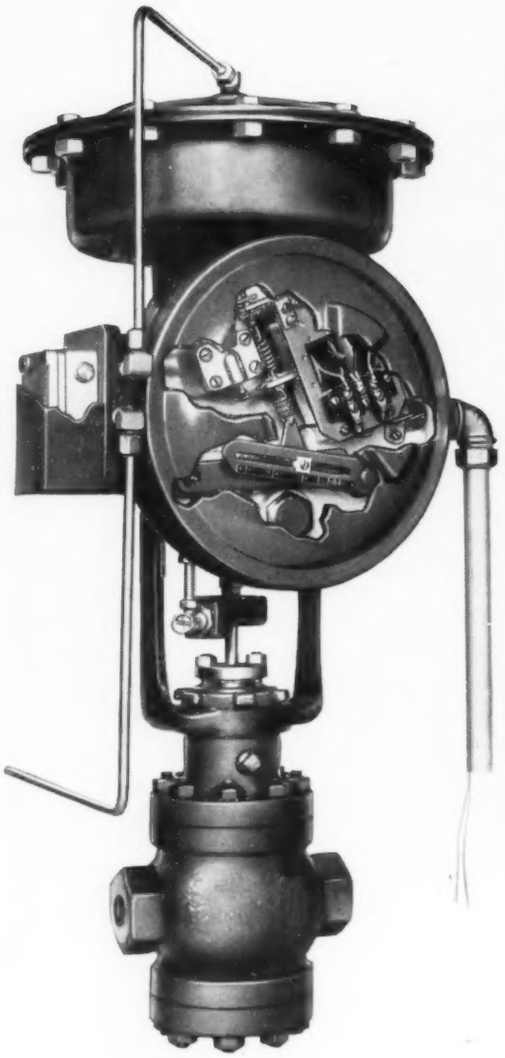
A skillful combination of new and proven design features, the Taylor 713R Valve Positioner converts an electrical milliampere input from the controller into a pneumatic force *insuring positive positioning of the valve actuator proportional to the electrical input.* It permits full utilization of the desirable characteristics of electronic control, coupled with the power and smooth throttling action of pneumatic valve actuators.

The 713R has unmatched stability, due to a powerful, balanced armature that reduces the effects of shock and vibration to a minimum. It is designed for use in hazardous areas designated for Class I, Group D, Division I equipment.

CHECK THESE FEATURES

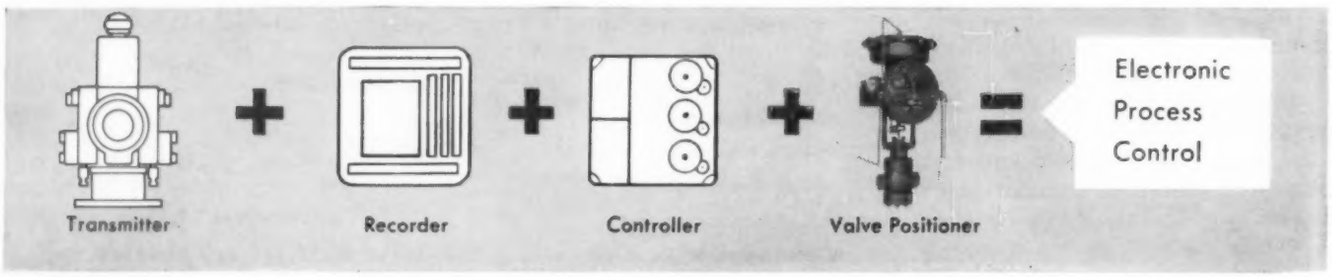
1. **High threshold sensitivity**—made possible by compact, powerful torque motor which positions stainless baffle with respect to stainless nozzle.
2. **Faster operating**—due to high capacity leakless booster relay.
3. **Wide supply pressure range**—operates with air supply pressure between 20 and 50 psi.
4. **Economy of installation and operation**—designed for use on regular plant air.
5. **Easy, safe servicing**—externally-mounted booster relay can be removed without breaking the electrical circuit, and without affecting its protection in hazardous areas.
6. **Standard input ranges**—1 to 5 ma, 4 to 20 ma, and 10 to 50 ma dc signal.
7. **Great adaptability**—same basic positioner can be applied to *reverse* or *direct* actuators, *reverse* or *direct* valve bodies, and other makes of actuators.

See your Taylor Field Engineer, or write for **Bulletin No. 98334.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.



Taylor Electro-pneumatic Valve Positioner mounted on new Taylor LIN-E-AIRE Valve Actuator.*

*Trade-Mark



Taylor Instruments **MEAN ACCURACY FIRST**

FINISH-GRINDING a 22-ton hardened steel roll for rolling aluminum. Overall length: 231 in. Diameter 34¼ in.

The finish must be perfect on this hardened steel roll

This Bethlehem machinist is finish-grinding the surface of this roll with utmost care. His intense concentration is nothing unusual; every Bethlehem roll is ground and polished with such care. When he completes this operation, the customer can be confident his specifications on finish have been met *exactly*.

Bethlehem pays the same careful attention to meeting customer specifications on hardness and dimensions. Every step in making a forged roll—from melting the steel to inspecting the finished product—is carefully checked, and then, just as carefully, double-checked. No roll is released until every technician on the job is completely satisfied.

When next in the market for forged rolls, why not check with us first? We make them in all sizes, and for every application: cold-rolling ferrous sheets and strip; running-down and finishing operations on copper and brass sheets; hot- and cold-rolling aluminum sheets; cold-rolling aluminum foil. Our prices and deliveries are fully competitive. Our nearest sales office can give you full details.

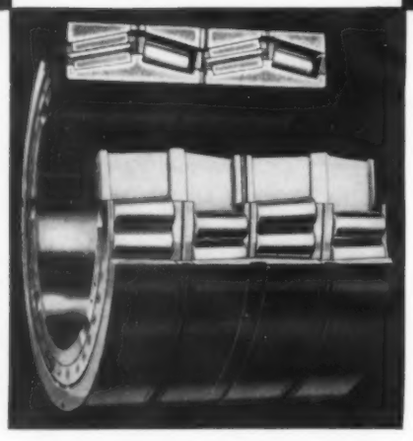
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export distributor: Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

BETHLEHEM STEEL

Pin-type retainer construction of Torrington Four-Row Tapered Roller Bearing provides maximum capacity in minimum cross section.



For Maximum Capacity and Life Expectancy
Torrington Roll Neck Bearings

In design, selection of materials and precision construction, Torrington spares no detail to insure maximum bearing capacity and life expectancy in roll neck bearings.

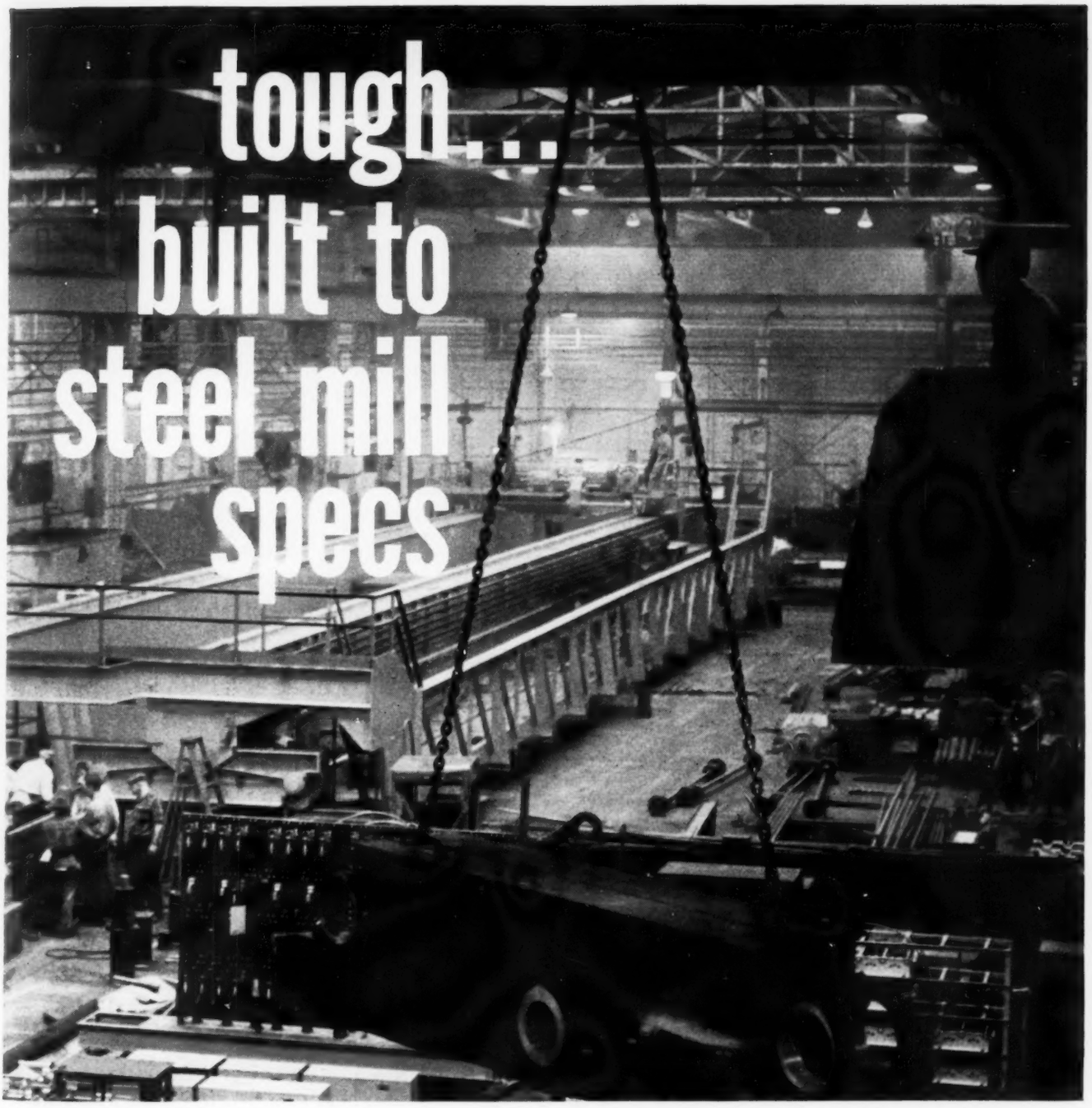
For example, where rolling mill window openings and roll diameters limit roll and bearing dimensions, Torrington design provides for minimum bearing cross section and maximum roll neck diameters. Rollers are longer and pin-guided to allow closer spacing and greater area of contact surface, providing a much greater load capacity.

Care in such details, and in proper selection of the *right* bearing for your application, pays off in tonnage rolled. For most satisfactory performance, make Torrington Bearings your selection. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST



This tough 30-ton Whiting Tiger Crane with a 125′ span is thoroughly checked out on the assembly floor . . . then it's off to rugged, round-the-clock steel mill service. Whiting cranes for mill service easily meet the highest set of standards in all industry, A.I.S.E. specs, or are built to exacting customer requirements. And important Whiting extras like oil bath lubrication, herringbone gears, and long life antifriction bearings assure added years of efficient, dependable maintenance-free operation.

Whiting is your answer to every overhead handling problem. Write for the facts on "Whiting-Engineered Cranes," bulletin 80. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois.*

75th year

COST-SAVING EQUIPMENT . . . THE WAY TO HIGHER PROFITS

CRANES

WHITING

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT

ILLINOIS GEAR has a world-wide REPUTATION

for Dependability and Superiority

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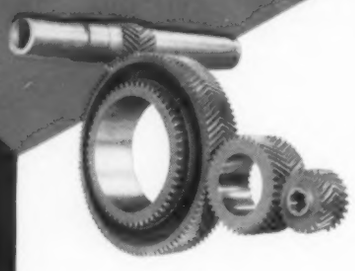

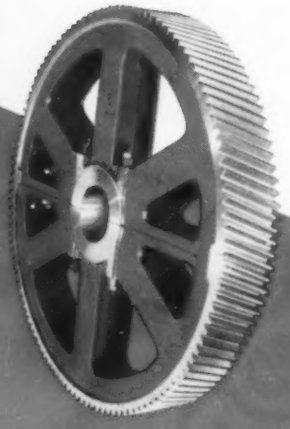

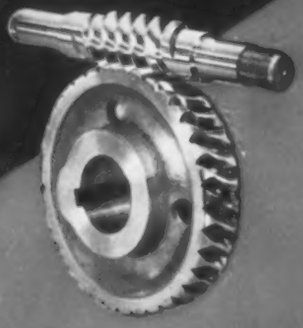

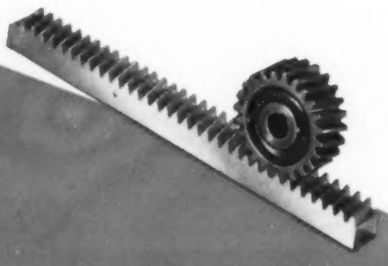

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Personnel News...

Walter F. Munford was elected president and chief administrative officer of United States Steel Corp. Mr. Munford succeeds **Clifford F. Hood,** who has reached the normal retirement age of 65. Mr. Hood, a veteran of more than 40 years in the steel industry and president of U. S. Steel since 1953, will continue to serve as a member of the board of directors and executive committee. Mr. Munford was also elected a director and chairman of the executive committee.

Mr. Munford had been executive vice president—engineering and research. For two years prior to that, he was assistant executive vice president of the corporation and, from 1953 to 1956, was president of U. S. Steel's American Steel and Wire Division. Mr. Munford started with the American Steel and Wire Division in 1923 at South Works in Worcester, Mass. In 1930, he transferred to National Tube Division at Lorain, Ohio, as assistant superintendent of the steel works, returning to the Wire Division in Cleveland in 1934 as assistant superintendent of its Cuyahoga Works. He was named superintendent there in 1937. Subsequently, he was assistant to the vice president of the Wire Division until his appointment as assistant manager of operations of the Pittsburgh District in 1939. In 1942, Mr. Munford was named manager of operations of the Worcester District. From that post, he moved to assistant vice president in charge of operations in 1945 and to vice president of the Wire Division in 1950.

Stephen M. Jenks was named executive vice president—engineering and research succeeding Mr. Munford. Mr. Jenks started with U. S. Steel as an engineer with the old American Sheet and Tin Plate Co. in 1925. Promoted to assistant chief engineer in 1935, he became chief engineer of the construction division of Carnegie-Illinois Steel Corp. in 1936. Mr. Jenks, in 1937, was named chief engineer of Gary Steel Works. During the same year, he was made assistant general superintendent of the plant, and general superintendent in 1940. In 1949, he was appointed manager of operations in the Chicago district for Carnegie-Illinois and, in 1950, became vice president in charge of operations. When Carnegie-Illinois became a part of U. S. Steel Co. in 1951, he was named vice president of manufacturing and, in 1953, assistant executive vice president—operations. In 1958, he became administrative vice president—central operations (steel & coal).

E. H. Gott succeeds Mr. Jenks in that capacity and **Oscar Pearson** succeeds Mr. Gott as administrative vice president—steel producing divisions.

E. B. Speer was named vice president—operations, succeeding Mr. Pearson. **R. W. Graham,** formerly general superintendent, Homestead Works, will replace Mr. Speer as general manager, operations—steel.

Robert A. McClure has been appointed general superintendent of Homestead Works, succeeding Mr. Graham, and **Theodore J. Koenig,** formerly assistant general superintendent at Homestead succeeds Mr. McClure as general superintendent at Gary Sheet and Tin Mill.

W. F. MUNFORD

S. M. JENKS

E. H. GOTT

OSCAR PEARSON

E. B. SPEER

R. W. GRAHAM

R. A. McCLURE

T. J. KOENIG

M. J. SMITH

LESTER ROCKWELL

E. T. WALTON

J. D. DARBY

M. J. Smith has been appointed division superintendent, Iron and Steel Division, at Kaiser Steel Corp.'s Fontana, Calif., plant. Mr. Smith comes to Kaiser from the steel division of Ford Motor Co. where he was manager of the open hearth and electric furnace division. He started in the steel industry in 1933 with Republic Steel Corp. in Buffalo, N. Y., first as a masonry laborer and advancing to junior melter. At the Chicago plant of Youngstown Sheet & Tube Co. he worked as a senior melter and first came to Kaiser Steel in 1946 as senior melter and general foreman in the Open Hearth Department. He left Kaiser Steel in 1948 to go to Ford Motor Co.

Lester Rockwell was appointed to assistant district industrial engineer in Republic Steel Corp.'s South Chicago steel district. Mr. Rockwell had been with Republic at the company's South Chicago steel plant since 1953, and was employed as a job classification engineer and craft incentive engineer.

E. T. Walton has been appointed director of metallurgy for the Crucible Steel Co. of America. He succeeds **D. I. Dilworth,** who resigned from the company to accept another post. Mr. Walton joined Crucible in 1923 as a contact metallurgist at the company's Midland, Pa., works. He held various metallurgical and inspection positions before transferring to the company's general offices in Pittsburgh in 1954 as a metallurgical engineer. He was appointed manager of customer technical services in 1958.

J. Douglas Darby was named vice president and assistant to president, United States Steel Corp. Mr. Darby had been an administrative vice president—commercial.

Leo DeFiore has been appointed director of engineering and **Carl J. Lucas,** chief engineer, the Youngstown Sheet and Tube Co. Mr. DeFiore, chief engineer for the company since 1956, joined Youngstown Sheet and Tube in 1917 as a draftsman in the engineering department. His service with Youngstown Sheet and Tube was interrupted in 1944 by employment in turn by the South Chester Tube Co., Morgan Engineering Co., and Portsmouth Steel Corp., where he became chief engineer in 1950. He rejoined Youngstown in 1956. Mr. Lucas joined Youngstown Sheet and Tube in 1946 as a detailer, became assistant district engineer in 1954, assistant to the chief engineer in 1956 and, in 1957, was named assistant chief engineer in charge of projects and development.

W. A. Marshall retired May 31, as works engineer Pittsburg, Calif., plant of the Columbia-Geneva Steel Div., United States Steel Corp., having served in that capacity since October, 1948. He worked in eastern steel mill plants until early in World War II when he joined the Navy Department, returning to the steel industry in the east. In 1948 he went to Columbia-Geneva Steel Div., San Francisco office. Mr. Marshall was awarded a plaque for his efforts as the leader in establishing the original West Coast Section of AISE from **George A. Teskey** at a recent San Francisco Section meeting. This West Coast Section has grown into the present San Francisco, Los Angeles, and Utah sections. Mr. Marshall was also recently made a life member of AISE for these efforts.

W. W. Sebald, vice chairman of the board of directors of Armco Steel Corp., chairman of its executive committee and former president, announced that he is retiring from all active duties, but will continue as a director of Armco. Mr. Sebald was president of Armco from 1948 to 1956. He retired as the company's president in 1956, on the anniversary of his 50th year of Armco service and was elected vice chairman of the board and chairman of its executive committee.

Albert J. Berdis, president of Weirton Steel Co. and Midwest Steel Corp., two divisions of National Steel Corp., was awarded one of the 1959 Horatio Alger awards. Mr. Berdis was one of nine leaders in industry, business, education and government who received the awards, which are presented annually by the American Schools and Colleges Association to emphasize that equal opportunity still exists in America and that it is possible to rise from humble beginnings by hard work, honesty and adherence to American ideals.

William Zatezalo has been appointed as open hearth superintendent at Weirton Steel Co., division of National Steel Corp. Mr. Zatezalo succeeds **J. R. Rath** who has retired after 31 years of service with the company. Mr. Zatezalo began his employment with Weirton in 1942 as assistant to the metallurgist in the Quality Control Department. In 1946 he was named assistant senior metallurgist, later was advanced to senior metallurgist and then to steel works metallurgist. In 1955 he was named assistant to the manager of the Steel Works Department and held that position until his current appointment.

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C. Melvin Smith has been appointed chief engineer for the Stainless and Strip Division of Jones & Laughlin Steel Corp. Mr. Smith, who was chief engineer and maintenance superintendent for the Division's Detroit, Mich., and Louisville, Ohio, plants, will have the engineering responsibility for the Division's plants in Detroit and Louisville as well as Canfield and Youngstown, Ohio, Kenilworth, N. J.; Indianapolis, Ind.; and Los Angeles, Calif. Mr. Smith has had more than 30 years' engineering experience in the steel industry. He joined Rotary Electric Steel Co. (now part of the J&L Stainless and Strip Division) as chief engineer in 1950. Prior to that, he was employed by Carnegie Illinois Steel Corp., Youngstown Sheet and Tube Co., and Freyn Engineering Co.

Astor L. Thurman has been named president of the Lombard Manufacturing Co. and vice president of Lombard Corp. Prior to joining Lombard he had been serving as a management consultant and consulting engineer to heavy industry, and will continue to maintain his consulting office. He previously was manager of West Virginia Works, Connors Steel, and executive vice president, Mannesmann-Meer Engineering and Construction Co. He has also served with The Aetna-Standard Engineering Co., and in the Steel Mill Division of General Electric Co.

Clark H. Johnson, vice president in charge of sales, United Engineering & Foundry Co., was elected to the company's board of directors.

Gordon Meldrum was named assistant chief metallurgist of Republic Steel Corp.'s central alloy district. **Virgil W. Whitmer,** who has been assistant chief metallurgist since 1946, will continue in this capacity concentrating primarily on stainless steels and the related specialty steels. Mr. Meldrum has been engaged in metallurgical work in the central alloy district since 1936. He started as a development metallurgist, was advanced to assistant laboratory director in 1939 and has been alloy metallurgist since 1957.

John M. Dugan was elected vice president of operations, Lima Division, Ohio Steel Foundry Co. Mr. Dugan has been with the company for the past 20 years and has held various positions in the operations department, the last of which was works manager and chief metallurgist of the Lima plant.

James E. Vargo was appointed wage and salary administrator at Weirton Steel Co., division of National Steel Corp. Mr. Vargo was first employed at the Duquesne Works of United States Steel Corp. as an industrial engineer, in 1942. In 1951 he was transferred to U. S. Steel's Fairless Works where he was a member of the industrial engineering department until coming to Weirton.

A. M. Killin was named assistant to works manager of Union Carbide Metals Co., division of Union Carbide Corp. Mr. Killin was formerly assistant manager of the Niagara Works of the company at Niagara Falls, N. Y. Mr. Killin began his industrial career at the Union Carbide plant at Sault Ste. Marie, Mich., in 1930. In 1949 he was transferred to Niagara Falls as assistant superintendent—carbide, becoming superintendent—carbide in 1950, assistant general superintendent in 1953, and assistant manager in 1954. Succeeding Mr. Killin as assistant manager will be **W. W. Heilman,** assistant technical director—alloys of the Technical Control Group. He started with Union Carbide at Alloy, W. Va., in 1940 transferring to Niagara Falls in 1954. Moving to Mr. Heilman's position as assistant technical director—alloys will be **W. M. Kelly,** plant metallurgist at the Niagara Works. Mr. Kelly joined Union Carbide Metals 1945 in metallurgical research. He worked in the Technical Control Group from 1952 until 1955 when he became plant metallurgist.

Frederick M. Gillies, chairman of the board of Acme Steel Co., was awarded the 90th Anniversary year tribute of the Western Society of Engineers. The society represents 2800 members in all fields of engineering throughout the Mid-West.

Samuel R. Parry, formerly vice president and general manager of the Chattanooga division of Combustion Engineering, Inc., has been appointed vice president in charge of manufacturing of the entire company. Mr. Parry joined the Combustion organization in 1923. He has held the positions of chief engineer, production manager, general superintendent and assistant general manager of the company's division at Chattanooga. **Harry J. Bolwell** was appointed general manager of the Chattanooga division. Mr. Bolwell was formerly assistant general manager at Chattanooga, and prior to that, manager of the company's nuclear components division.

Harry D. Ruch was appointed product sales manager for Minneapolis-Honeywell Regulator Co.'s newly developed line of electric instrumentation. Mr. Ruch

A. L. THURMAN

C. H. JOHNSON

GORDON MELDRUM

J. M. DUGAN

Formerly, slip rings were reground every 6 to 8 weeks!
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STILL GOIN' STRONG
STILL GOING STRONG
MAINTENANCE DEPARTMENT

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(the day they switched to NATIONAL TRADE MARK Brushes)

LOUIS J. ESPOSITO

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Not only did a costly problem disappear, but plant management also was able to release service facilities for better maintenance elsewhere.

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C. P. HAMMOND (left)
A. L. FOELL (center)
A. W. KNIGHT (right)

joined the company's Brown Instruments division in 1939 and for 12 years previous to his present assignment he was field sales engineer for the Philadelphia branch office.

Charles P. Hammond has been assigned by the United States Department of State to Zenica Yugoslavia, under a contract with the International Cooperation Administration, to assist the Yugoslav Government in the improvement of its steel mills. Mr. Hammond has been associated with the steel industry in the United States for the past 45 years and was formerly chairman of the Buffalo section, as well as a director of the AISE.

A. L. Foell was elected a director of Arthur G. McKee & Co. Mr. Foell, also a vice president of the company, is in charge of all consulting services for McKee's customers.

Alfred W. Knight was elected president of the Western Precipitation Corp. He succeeds **Walter A. Schmidt,** who remains as chairman of the board. Mr. Knight joined the company in 1924. He was elected vice president in 1938 and was made executive vice president and general manager in 1956. Mr. Schmidt had served as president since 1911. He joined Western Precipitation shortly after it was incorporated in 1907 and has directed its operation for 48 years.

Gregg N. Moga has been named a vice president of Strategic Materials Corp. In his new position Mr. Moga will work jointly for Strategic and Koppers Co., Inc., as a special sales representative developing potential applications for the Strategic-Udy smelting-refining process. Prior to his new appointment, Mr. Moga held a number of sales and plant management positions with National Carbon Division, Union Carbide Corp. Since 1951, he has been manager of submerged arc applications. In addition to his duties with the Strategic-Koppers direct smelting operations, Mr. Moga will continue to serve as a special consultant to National Carbon.

Robert L. Jones has been elected executive vice president in charge of engineering, and, a member of the board of directors of Berger Engineering Co. Mr. Jones was formerly associated with Koppers Co., Inc.

Thomas M. Brickley, Jr., has been named district manager of the newly-created Milwaukee, Wis., district office of the Okonite Co. Mr. Brickley was formerly associated with Brickley and Co., manufacturers' agent, of Milwaukee. At the same time, **James R. Haden** was appointed district manager of the newly-designated Kansas City, Mo., district office. Mr. Haden has operated this office, formerly a branch of the St. Louis district, since 1954.

John E. Johnson has been appointed assistant to the chief engineer of the Buffalo, N. Y., plant of Republic Steel Corp. Mr. Johnson, who joined Republic 10 years ago, has been a field engineer at the plant since 1955.

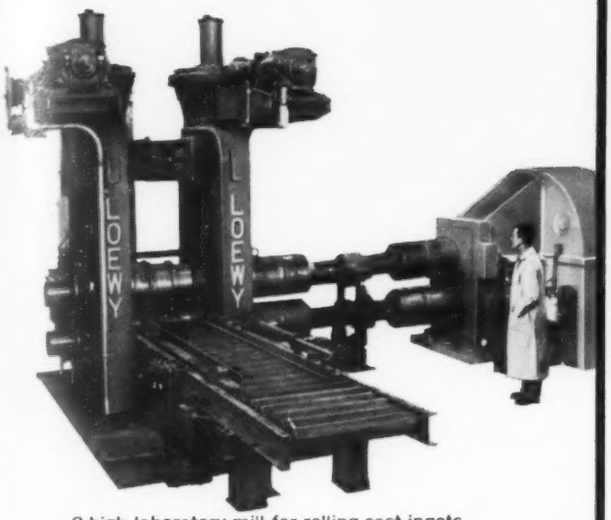
Robert E. Hebert, a metallurgist for four years at Vanadium-Alloys Steel Co., was named to serve as manager of the new Vacuum Melting Department. At the same time, **C. J. Stalnaker** was named product metallurgist in the same department.

James E. Martin has been named Cleveland district manager of the Pangborn Corp. Mr. Martin succeeds **Robert E. Donnelly** who recently retired after 30 years service with the corporation.

Ernest E. Swartswelter has been elected a director and vice chairman of Blaw-Knox Co. Mr. Swartswelter was chairman of the Aetna-Standard Engineering Co., recently acquired by Blaw-Knox.

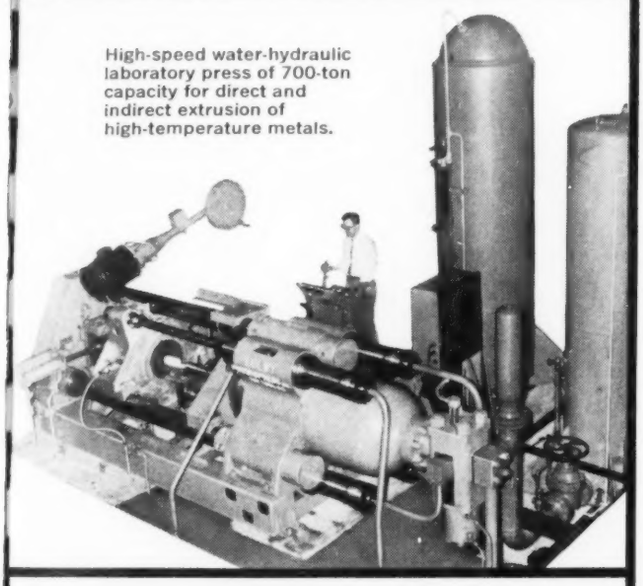
William E. Carter has been named branch sales manager in the Pittsburgh area for Exide Industrial Division of the Electric Storage Battery Co. He succeeds **Robert L. Kegg** who resigned to establish his own business. Mr. Carter, who has been with the company for nearly 10 years, takes over sales and service of industrial batteries and related equipment in a territory which covers western Pennsylvania, West Virginia and several counties in Kentucky, Maryland, Ohio and Virginia.

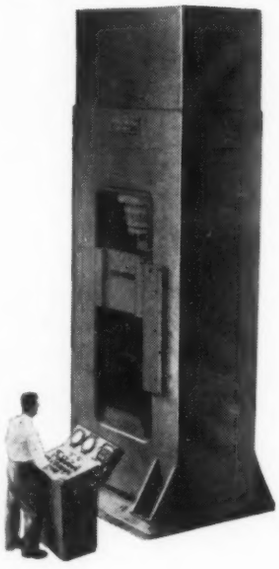
E. E. SWARTSWELTER
W. E. CARTER



2-high laboratory mill for rolling cast ingots and forged and rolled billets of ferrous and nonferrous material into squares and rounds.

High-speed water-hydraulic laboratory press of 700-ton capacity for direct and indirect extrusion of high-temperature metals.





High-speed universal laboratory press of 500-ton capacity with hydraulic cushion. This press is designed for extrusion, drawing, forging and other forming operations.

Loewy laboratory presses and mills offer extraordinary flexibility

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All of those capabilities will be found in Loewy-Hydropress laboratory equipment for rolling, extruding, open forging, die-forging, compacting, drawing and rubber-pad forming. Many press-forming operations can sometimes be carried out on the same Loewy machine with but little adjustment.

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Charles A. Jacoby has been named superintendent and **William E. Rice, Jr.,** assistant superintendent of the Construction Department, Crucible Steel Co. of America. **John N. Hancock** was named superintendent of the Maintenance Department with **William D. Drummond** as assistant superintendent. **Dwight F. Burns** was appointed to fill the post of superintendent of shops and **Nicholas Kleon,** assistant superintendent.

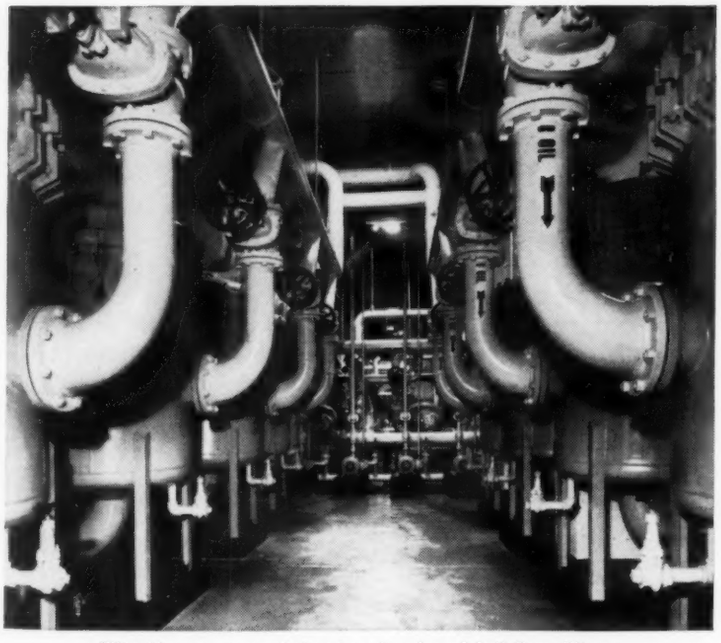
Mr. Jacoby joined Crucible in 1957 as assistant to the superintendent of Construction and Maintenance. He had previously spent four years as maintenance supervisor of the Structural mill at the Homestead works of United States Steel Corp. Mr. Hancock joins Crucible after 18 years of service with the Steel Division of the Ford Motor Co.'s Rouge plant in Dearborn, Mich. He was superintendent in the basic mill area. Mr. Burns began his employment at Midland works in 1926. In 1944 he was named general foreman in the Structural and Car Repair Departments, a position he held until his present appointment. Mr. Rice came to Crucible in 1956 as foreman in the Labor Department, a position he held until his present appointment. Before joining Crucible in 1952 as maintenance foreman in the Midland works Coke plant, Mr. Drummond held jobs with U. S. Steel Corp. and Jones & Laughlin Steel Corp. Mr. Kleon joined Crucible in 1952 as a general maintenance foreman and has held this position until his present appointment.

D. Bedell Baxter has been appointed to the newly created post of assistant to the vice president—service engineering, Basic, Inc. He was in the company's refractory sales division for 19 years and was sales manager of the Pittsburgh district when he left the company in 1958. **David E. Holmgren** has been appointed sales development engineer.

Thomas P. Stanton will be in charge of the new Eastern sales office, with headquarters in Philadelphia, Pa. He is presently district sales manager with offices at Basic's Hammond, Ind., plant. Mr. Stanton has been with the company since 1945. **George J. Peer** will become Midwestern district sales manager with headquarters in Hammond. From 1954 to 1957, Mr. Peer was a sales engineer for Basic in this same territory. **Ralph E. Forsman,** sales engineer, will move from the St. Louis, Mo., office to Hammond. **Charles J. Tyson,** formerly located in Philadelphia, will take over at St. Louis. This sales office, formerly a part of the Midwestern district, will thereafter function separately, supervised directly from Basic's general offices in Cleveland.

Edwin J. Smith, formerly research supervisor—coated products, has been promoted to the position of associate director in charge of promotion research, National Steel Corp. At the same time, **Harry H. McFeely** was transferred to the Research and Development Department as supervisor—electromechanical research from the Weirton Steel Co. division electrical department, where he had been electronic supervisor; **Louis C. Beale, Jr.,** was named associate director in charge of process metallurgy. He formerly was associated with

Dual Dravo-DeLaval coolant systems for new 31-inch cold strip mill



Filtration area contains two banks of full flow filters for cleaning mineral oil and water soluble coolants.

A new Sendzimer cold strip mill, built for the Scovill Manufacturing Company, Waterbury, Conn., which will roll both aluminum and brass, is equipped with a twin, custom-designed Dravo-DeLaval coolant and lubricating system. One system supplies mineral oil when aluminum is being rolled, and the other soluble oil and water for brass.

The dual design permits instant switching of lubricants to match frequent mill changeovers. Coolant is supplied at the rate of 750 gallons per minute at a 350-foot head, and each system includes a 15,000 gallon 3-section reservoir. Dual pumps are provided, one for the coolant system itself, and one for the cooling circuit. Cartridge type, full-flow filters which remove foreign particles as small as 15 microns assure clean oil at the mills.

Completely engineered by Dravo, this unusual dual installation was quickly and easily put in service, and required no engineering time at the site. For information on how high efficiency, Dravo-DeLaval oil systems can save you time and money, write Dravo Corporation, Pittsburgh 22, Pennsylvania.

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Batelle Memorial Institute where he was assistant division chief for the past 13 years; **Ralph A. Maggio** was placed in charge of operations research covering the use of applied mathematics and computers to the solving of research and operating problems. He had been a staff statistician with the Jones & Laughlin Steel Corp.

George F. Burley was reappointed vice president for sales of Crane Co. Mr. Burley joined Crane as vice president in 1957. Other appointments announced were: **Clarence E. Watson,** general manager of atomic energy sales; **Darrell R. Nordwall,** general manager of branch sales; **Charles H. Lovelace,** general manager of engineering sales, and **R. W. Lindsay,** general manager of wholesaler sales.

J. Allan MacLean was elected president of Dodge Manufacturing Corp., succeeding **Joseph E. Otis, Jr.,** who has been elected chairman of the corporation's board of directors.

Peter Arnold has been promoted to the sales engineering staff of Hanson-Van Winkle-Munning Co. Mr. Arnold became associated with the company as a consulting engineer in 1954. He joined the Engineering Department in 1955, specializing in automation and material handling.

P. C. Fourney has been appointed assistant works manager of Union Carbide Metals Co., division of Union Carbide Corp. He began his service with Union Carbide Metals Co. at Alloy, W. Va., in 1940. After a period in the Production Department he was transferred to industrial relations where he served as supervisor of labor relations. In charge of industrial relations from 1946 until 1955 he then became executive assistant to the manager, in 1956 became assistant manager, and was named manager later that year. His successor as manager of the Alloy Works will be **John Winterhaler** who has been assistant to works manager. He began his career with Union Carbide Metals as a student engineer at the Company's Niagara Falls, N. Y., plant in 1942. Mr. Winterhaler became assistant to the superintendent of the special alloys division in 1949, and two years later was appointed assistant superintendent of this division. In 1955 he was transferred to Ashtabula, Ohio, as superintendent of Union Carbide Metals' new titanium sponge plant, coming to New York to assume his present position in 1958.

Clement E. Sutton has been appointed manager of marketing in the General Electric Co.'s Gas Turbine Department. Mr. Sutton, who has served as manager of marketing for the company's Apparatus Service Shops Department, succeeds **Edward G. Naylor** who has been named to the newly-created post of manager of plant subcontracting operations in the Schenectady public and employee relations department.

Mr. Sutton joined General Electric in 1934 on its test program in Schenectady and at Pittsfield, Mass., where he was employed in the high voltage engineering laboratory and later in the power transformer engineering division. In 1939, he transferred to sales and trained three years in various sections prior to moving to Philadelphia, Pa., as district transformer specialist. In 1948, he was named assistant manager of power transformer sales and in 1949 became manager. He was appointed manager of distribution transformer sales in 1952, and in 1956, became manager of marketing for the Service Shops Department.

Mr. Naylor joined GE as a member of the test program in 1940. From 1941 through 1944 he was assigned to turbine sales in Schenectady, and in 1946 was appointed turbine specialist, Chicago district, where he served until being named manager of sales, Gas Turbine Department in Schenectady in 1952. Mr. Naylor was appointed acting manager of marketing in 1956. In 1957 he was appointed manager of Gas Turbine Marketing.

Joseph P. Wood has been named to the newly-created position of power equipment consultant of I-T-E Circuit Breaker Co. He will serve on the staff of **G. E. Heberlein,** engineering vice president, and assist on sales negotiations, engineering studies and power apparatus projects which incorporate the firm's air and oil circuit breakers. Prior to this appointment, Mr. Wood was adviser on high voltage engineering for the company's switchgear division. Before joining I-T-E in 1943, he was president and chief engineer of Roller Smith Co.

Robert M. Hatfield, formerly vice president in charge of manufacturing of Combustion Engineering, Inc., has been appointed vice president and general sales manager in charge of domestic sales. Mr. Hatfield joined Combustion in 1934.

Obituary

Russell Lowell, roll designer, Continental Steel Corp., died April 6.

More clean water at a lower cost with...

S.P.KINNEY AUTOMATIC SELF-CLEANING

STRAINERS

. . . for efficient removal and disposal of suspended particles from raw or process water and other liquids

- ✓ Over 1000 installations
- ✓ 2″ to 48″ pipeline sizes
- ✓ Installation on pressure or suction side of pump
- ✓ Over 8 billion gallons per day installed capacity
- ✓ Large variety of straining media

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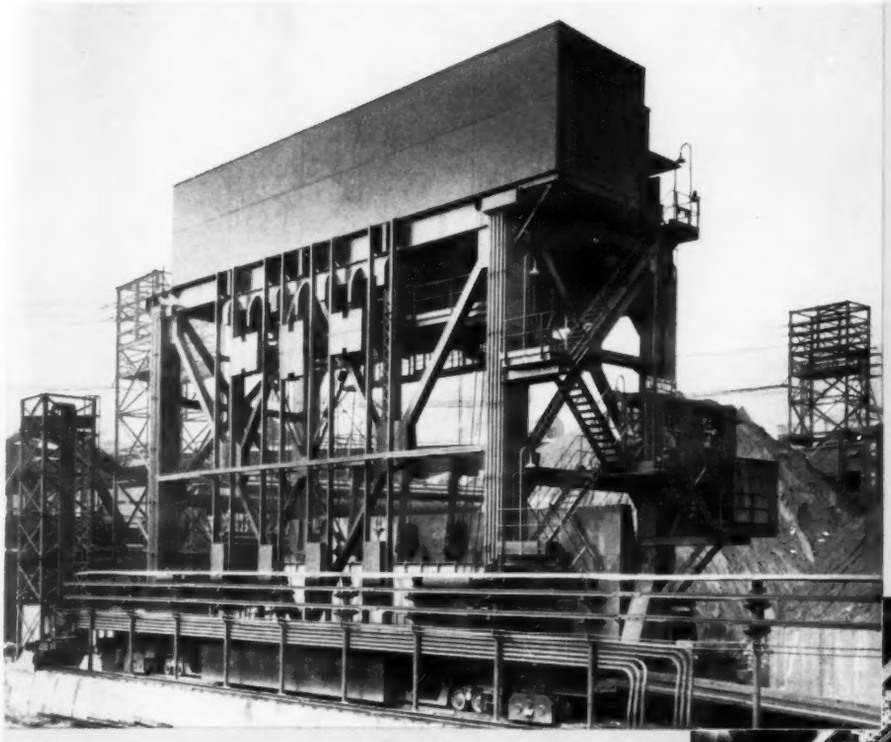
Write today for Bulletin 500.1 and list of installations

S.P. KINNEY ENGINEERS, Inc.
CARNEGIE, PENNSYLVANIA



Heyl & Patterson
Car Dumper

P-G Resistors
control this 300 ton car dumper

Non-breakable Post-Glover resistors do their part in keeping this 300 ton car dumper in round-the-clock operation at Weirton Steel Company division of National Steel Corporation, Weirton, West Virginia.

These rugged, shock resistant P-G Standard Unit Resistors are built of steel and mica. With nothing to break, they have afforded low cost protection to many types of expensive and vital electrical equipment for more than twenty years.

When you want "continuous trouble-free service" specify, P-G the ORIGINAL Steel Grid Resistor.

Note that ample terminals are available for adjustments if required to meet actual operating conditions.

Established 1892

Write for Bulletin No. 500

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky

Inspection of 75-foot Salem Rotary Hearth Furnace at The Timken Roller Bearing Company plant at Canton, Ohio.

Rotary hearth roof of B&W IFB gives nine years of service at the Timken Company

Installed as a replacement for a super-duty firebrick sprung arch, over 35,000 B&W Insulating Firebrick were used in the roof of this rotary hearth furnace. Since installation nine years ago, just 300 9″ equivalents have been used for maintenance—less than 1% replacement!

Throughout this period the furnace has been operated at temperatures ranging from 2100 F to 2300 F on a continuous 6-day cycle at an average output of 20 tons per hour.

In addition to long service life, lightweight B&W Insulating Firebrick provide high fuel savings because of their low heat flow and heat storage. Lightweight IFB also simplify original furnace construction...make maintenance and patching easier.

For more information on long-lasting, cost cutting B&W Insulating Firebrick, consult your B&W Refractories Representative or send for Bulletin R-2-H.

B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

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R-598

VAUGHN® MOTOBLOX® HRX

SIZE and CAPACITY

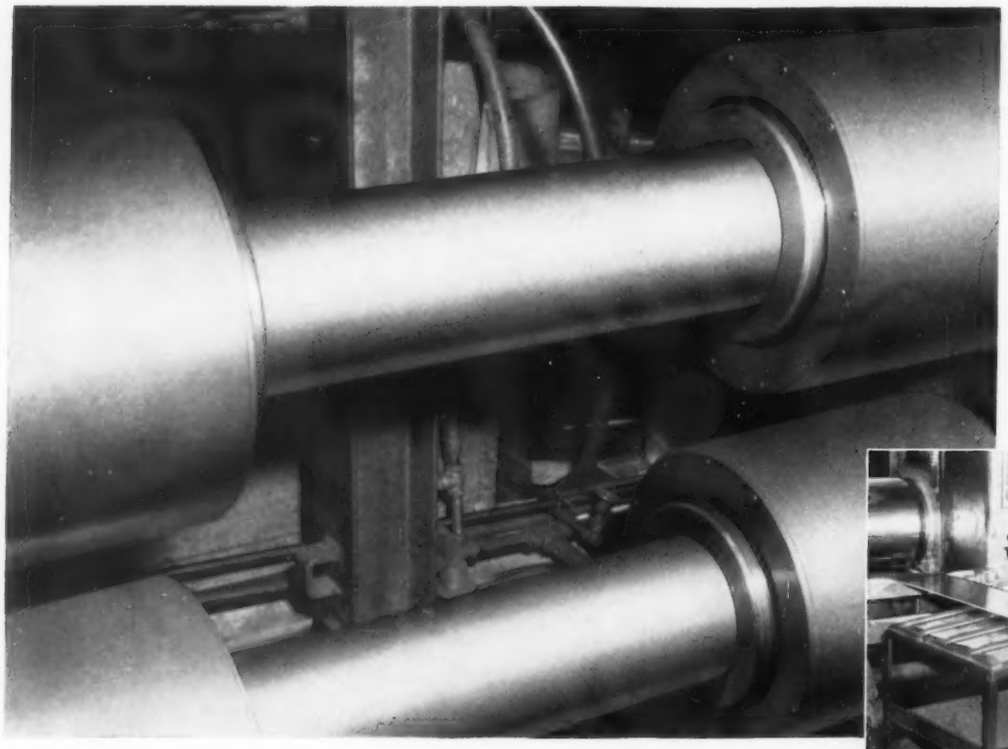
for drawing largest wire sizes **CONTINUOUSLY** *without preliminary breakdown*

This is the big boy! Here is capacity in plenty to meet the ever-increasing demand for prestressed concrete wire and bridge wire at high production rates. The Vaughn HRX MOTOBLOX does a *double-cooled* (air *and* water) job of continuous operation on large wire sizes without preliminary breakdown—for instance, it will finish .70 carbon .192″ diameter wire from .437″ diameter rod at 1000 fpm. Equipped with 30″ intermediate blocks and 36″ finishing block, the Vaughn HRX can be obtained in packaged or conventional design. ● Let us give you the profit-making details!

THE VAUGHN MACHINERY COMPANY

Cuyahoga Falls, Ohio, U. S. A.

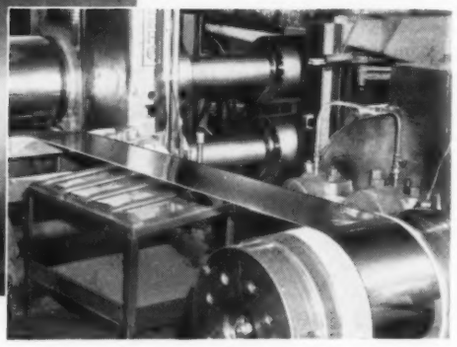
COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.



Close-up view of two AJAX Dihedral Spindle Couplings used on a modernized skin sheet mill. Each coupling has been operating at a torque of 50,000 Foot Pounds driving 20" diameter rolls running at 15 to 40 RPM for

FOUR YEARS
with
MAINTENANCE
REDUCED TO ZERO

Lower photograph shows general view of installation.



AJAX® DIHEDRAL SPINDLE COUPLINGS

are NOT sold "OFF-The-Shelf"

When you buy, build or modernize a mill, AJAX engineers design the spindle couplings especially for your conditions.

Every requirement of angularity, offset, speed, power, load, and dimensions is coordinated into the final specifications.

Hundreds of AJAX Dihedral Spindle Couplings are establishing new standards of production on mills in the United States, Canada, England, France, Sweden and other countries. This puts a world of experience into AJAX design.

The result is a carefully engineered, smooth running, spindle drive with constant peripheral speed, freedom from backlash, sealed-in lubrication and savings of thousands of dollars of maintenance and down time costs.

AJAX Dihedral Spindle Couplings make possible mile-a-minute speeds, close gauge tolerance, better surface finish, longer roll life, and far less down time.

A reprint of a paper presented before the Association of Iron and Steel Engineers will give you authoritative information covering their contribution to mill performance is given in AJAX Bulletin 64. Consult the yellow pages of your phone book, or fill in coupon below for your copy.

AJAX®

AJAX FLEXIBLE COUPLING CO. INC.
20 Portage Road, Westfield, N. Y.

Please send latest AJAX Dihedral Spindle Coupling Bulletin No. 64.

Name _____

Concern _____

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EF Continuous Galvanizing Lines

assure unvarying uniformity of anneal and coating; high daily outputs with no un-scheduled downtime.

TOTAL DESIGN CAPACITY IN EXCESS OF 2,460,000 TONS PER YEAR*

Tailored to meet your specific requirements and incorporating the most advanced techniques, EF continuous galvanizing lines assure users high heating efficiency — accurately controlled cycling — and month after month of continuous, trouble-free, 24 hours a day, 7 days a week operation. You get maximum production — and return — per dollar invested.

The unvarying uniformity of product physicals — the bright even spangle — and the tight bond of the coating, preventing chipping or flaking — assure high market acceptance, and make subsequent forming and fabricating operations more efficient and less costly.

For utmost efficiency and economy on galvanizing operations, and all other continuous, or batch, heat treating of ferrous, non-ferrous or alloy materials, you'll find it pays to consult The Electric Furnace Company heat processing engineers.

*Tonnage output will vary depending upon width and gauge of strip being processed.

THE ELECTRIC FURNACE CO.

Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

300 West Wilson Street *Salem, Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn., Canadian Associates, Canefco Limited, Toronto 13, Ontario

TRABON®

CENTRALIZED LUBRICATING SYSTEMS

How to lubricate bearings you can't see, reach or touch

Automatic transmission housings get bored, faced and chamfered on this Ex-Cell-O machine. One hundred sixty-four an hour! Helping to make this mass production possible, is the fact that bearings are automatically lubricated by a Trabon Centralized Lubricating System from one central location **without shutting the machine down.** No need to poke around to see if hard-to-reach-see or touch bearings are getting the lubricant they need. A centralized control panel tells the whole story. Without moving a step, the machine operator is told by colorful lights that lubricant is being delivered to all bearings in exact measured amounts according to a pre-determined schedule. Isn't this the lubrication assurance your machines need? Write today for further information!

A battery of Ex-Cell-O Duplex Vertical Machines rough and finish aluminum automatic transmission housings for one of the "Big Three" auto producers. "Whitened" two Trabon HLJ 25 (hydraulically operated) pumps, feeders and control panel make up the automatic Trabon Centralized Lubricating System protecting 22 points of lubrication on these intricate machine tools.

"Centralized" OIL AND GREASE SYSTEMS *"Meterflo"* CIRCULATING OIL SYSTEMS

Trabon **Trabon Engineering Corporation** 28785 Aurora Road • Solon, Ohio

Equipment News...

OIL CIRCUIT BREAKERS

△ The Westinghouse Electric Corp. has extended the rating of the single-tank oil circuit breaker from 250 mva to 500 mva at 14.4 kv while reducing the interrupting time to three cycles.

Tests were conducted throughout the current range. Even for currents between 25 per cent ratings and zero amperes, the interrupting time is essentially three cycles.

The interrupters were redesigned using the principles of the tubular-type "De-Ion" grids which are used on the high-capacity oil circuit breakers.

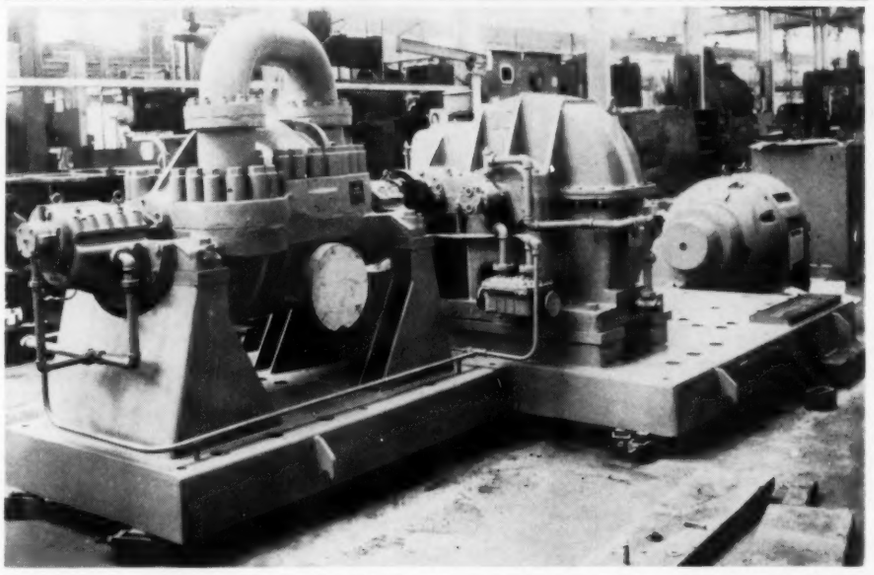
With this design, the grid stack is enclosed except for the exhaust vents, and the contact entrance hole is located at the bottom of the breaker. Interruption is accomplished by deionizing action throughout the current range that results from self-generated pressure inside the grid. The effect is shorter arcing times, particularly on lower current interruptions.

Butt contacts are used to get high-speed contact parting time. These contacts meet the required 40,000-ampere momentary and 25,000-ampere four-second rating. When the 1200-ampere continuous current rating is needed, an additional contact is mounted outside the grid stack.

A new solenoid operating mechanism is used on the redesigned breaker. The new mechanism permits a reduction in closing current from 65 amperes to 35 amperes at 125 volts direct current, or 230 volts alternating current. This means that a three-kva transformer has enough capacity to close the breaker.

When a battery is not available for tripping, a capacitor shunt trip device can be used. This device is used for tripping circuit breakers from an a-c voltage source by using the stored energy in the capacitor for tripping energy. Reliable shunt tripping from a 230 a-c voltage source with any relating scheme is possible with this device.

LUKENS ORDERS HIGH-PRESSURE DESCALING PUMPS



Among the first to adopt the European practice of high-pressure descaling, Lukens Steel Co. has ordered two 1600-psig pumps from De Laval Steam Turbine Co. to introduce the development at their Coatesville, Pa., plant. Cold water descaling of steel slabbed ingots at pressures of 1000 to 1200-psig has already been successfully used by steelmakers in this country and abroad. Superior results with pressures in the higher 1500-to-1600 psi range, at European steel plants has attracted attention from U. S. steelmakers. The pumps ordered by Lukens are of the split-case multi-stage type shown here. Each pump supplies cold water at 1000 gpm against 3700 ft of head. Electric motors to drive the high-pressure pumps are rated at 1750 hp. Speed increasing gear raises the 1200-rpm motor speed to 4250 rpm for the pumps.

STRIP WINDING CONTROL

△ B. S. Roy & Son Co. have announced the development of a strip winding compensator which accurately controls the winding of wire strip on a mandrel. This unit eliminates expensive air pressure guides or other types of winding guide controls.

Strip ranging in widths from 3 in. to 25 in. and 0.010 to 0.070 in. thickness have been processed without damage to strip's edges or surfaces. An oscillating guide prevents damage to strip edges during the winding operation. Power is furnished by a one horsepower motor easily mounted near the mandrel. Each compensator is furnished with rubber rolls, hardened guide bars (adjustable from 3 to 26 in.) hardened and ground drive shaft rotating in bronze bushings and a drive sheave.

Mounting is accomplished with a flat steel plate enabling the complete unit to be mounted uniformly on any flat surface in promixity with the winding mandrel. Proper strip tension control is possible.

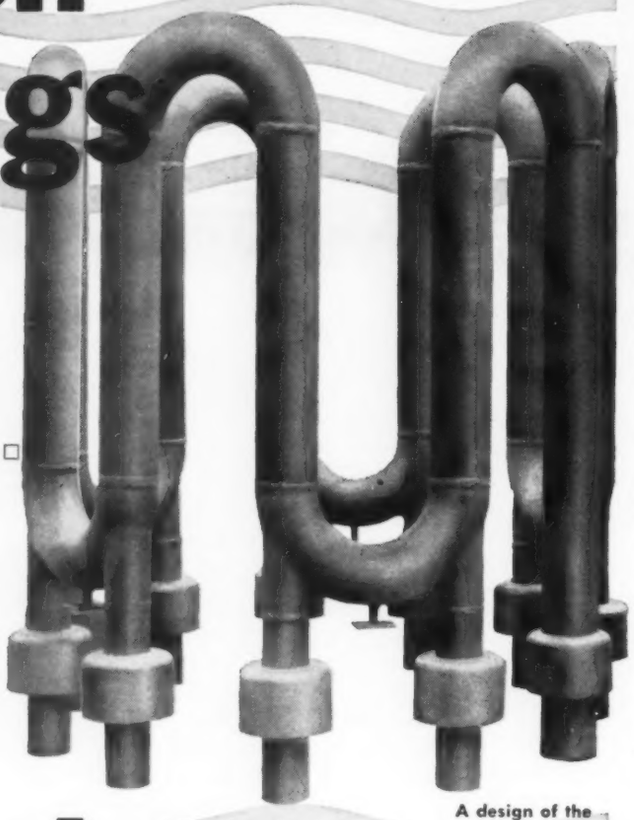
PUMPS

△ Addition of two new models to their line of reciprocating and centrifugal pumps has been announced by the Wilson-Snyder Works of U. S. Steel Corp.'s Oil Well Supply Division.

One of the new models is a 500-hp centrifugal pump capable of delivering 12,000 gallons a minute to a 150-ft head. The other is a 28.5 hp general service reciprocating pump with a capacity of 126 gallons per minute.

The 500-hp model is a 16-in. double volute, double suction pump, designed primarily for water supply

when things are HOT... call on Duraloy



A design of the A. F. Holden Co., Detroit, Mich.

Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

transfer service and other large capacity, relatively low-pressure operations.

It will be produced on special order, with all parts made of the materials best suited for conditions of service. This will permit customers to consult with company engineers as to the use of stainless steel, bronze or various alloys in the shafts, sleeves, impellers, wear rings and other parts which might be subjected to corrosive agents in special applications.

The smaller model, to be known as the 246-P, is one of the smallest pumps ever produced by Wilson-Snyder. It develops a maximum working pressure of 600 psi.

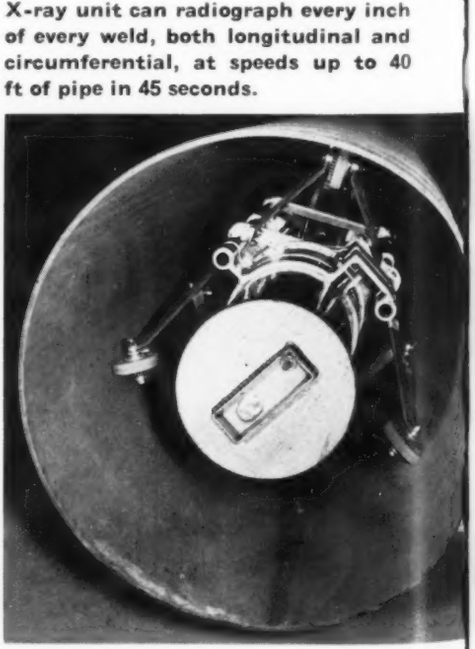
For use with salt water or other corrosive agents, the 246-P can be supplied with valves and pistons of stainless steel, bronze or various alloys.

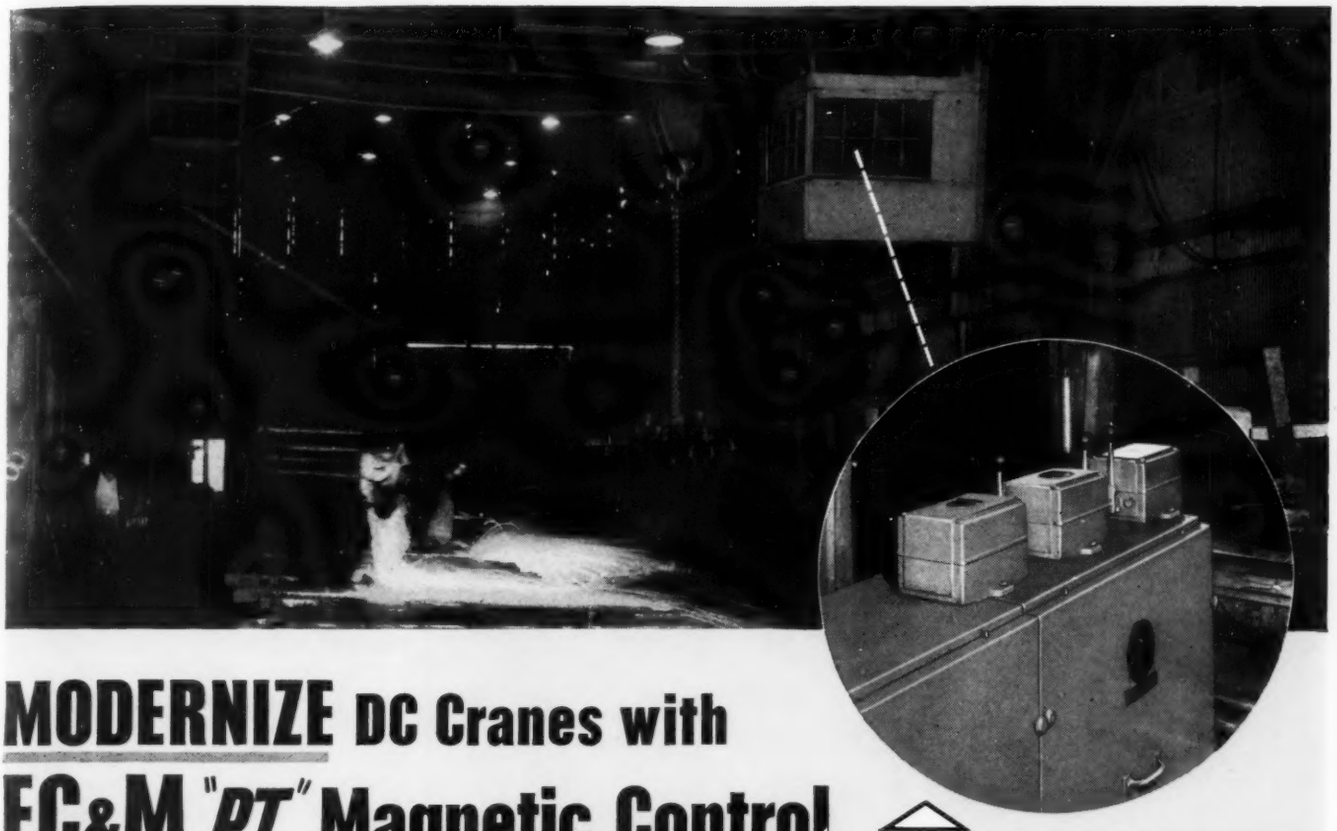
PIPE WELD X-RAY

Δ A new machine which can radiograph every inch of every weld in a 40-ft length of pipe in less than one minute has been announced by the Travel-Ray Corp.

The new equipment, trade-named "Travel-Ray," incorporates an x-ray tube of patented design which projects a narrow beam of parallel rays only, permitting radiography of the longitudinal welds in pipe sections while the x-ray source is in motion. The relative speed of the machine virtually eliminates the

X-ray unit can radiograph every inch of every weld, both longitudinal and circumferential, at speeds up to 40 ft of pipe in 45 seconds.





MODERNIZE DC Cranes with EC&M "PT" Magnetic Control

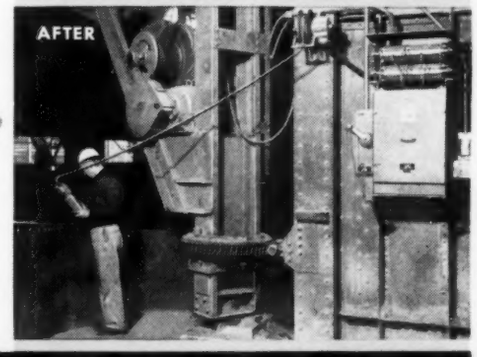
Three-motion crane serving scarfing area in mid-western steel plant uses "PT" control for bridge, trolley and hoist motions. EC&M Tab-Weld resistors are mounted on bridge foot-walk. Two "PT" controllers, replacing manual controllers, are mounted at front of cab. Third controller is at rear of cab, and all three master switches are up front within easy reach of operator. Since converting to "PT" control, there is more room in cab.

Is *manual* control penalizing crane operation in your plant? Are motors and machine subjected to abnormal conditions during acceleration and plugging? Is output affected by the slower reaction of operators as they tire under the strain of manual control on an all-day's run?

EC&M "PT" Magnetic Control erases these deficiencies. Timed acceleration and rectifier-plugging protection cuts motor abuse. Compact, easy-operating master switches provide a new "feel", enabling the operator to increase output.

The illustrations shown here are typical of the acceptance of EC&M "PT" control for DC Cranes. One plant has a modernization program under way involving dozens of cranes. Physically, "PT" control occupies about the same space as manual control. The cost is comparable, too.

Convert now to "PT" control. This *magnetic* control is far superior to manual control.



Jib crane, shown at top with old manual controller, is now operated by "PT" magnetic control (bottom). Pendant pushbutton provides remote control, gives operator better view of open hearth floor. "PT" control can be operated, without change, by either master switches or pendant pushbutton. "PT" control is front wired, front accessible, for mounting against walls or crane girders.

Write for complete details on "PT" crane control. Ask for Bulletin 6131.

2950

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

WHEREVER ELECTRICITY IS DISTRIBUTED AND CONTROLLED

"scatter" radiation problem inherent in stationary radiography by conventional techniques. Sensitivities of 1 to 1.5 per cent are obtained as a result.

The projector may be compared to a spotlight, which produces only parallel light rays and casts sharp shadows free from distortion or magnification. Conventional x-ray equipment, conversely, operates somewhat like a floodlight, emitting a wider beam of diffused rays, intensifying the "scatter" radiation effect, and requiring that the x-ray source be motionless for satisfactory exposures.

Up to 2000 ft of pipe can be x-rayed in one continuous operation without stopping the machine. Pipe can be x-rayed at the mill, in the field, at river-crossing sites, and elsewhere, vastly accelerating pipeline operations at every stage. The equipment can also be used to radiograph only circumferential welds if desired, which it does much more rapidly than conventional equipment.

The equipment is easily adjustable for pipe diameters from 12 through 36 in., features special six- and 12-wheel drive crawlers, and offers variable band width, speed and power up to 250 kilovolts. A quick-disconnect cable eliminates the need for reversing the motor at the end of the pipe section, and a patented rail system is available for pipe mill and other high-production applications.

ADJUSTABLE DRIVES

△ An entirely new line of packaged adjustable speed drives has been introduced by General Electric Co.

The new "Polydyne" series represents the first mechanical adjustable speed drives to be offered by the company's Gear Motor and Transmission Components Department.

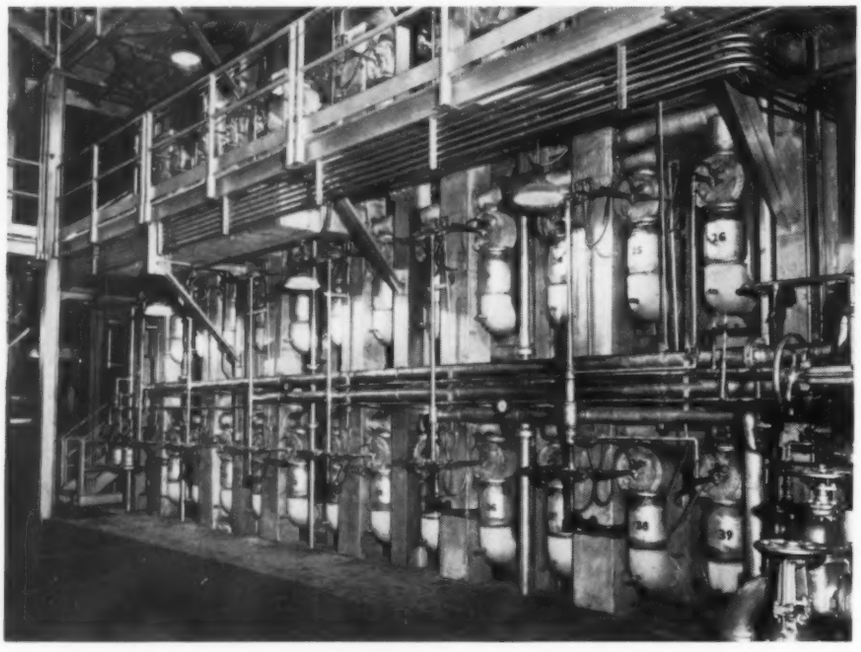
The drives, available in a wide range of outputs and speed ratios, operate on the principle of V-belt-connected, adjustable pitch pulleys.

Belt replacement is enhanced by a design which assures adequate internal clearances. This was made possible, engineers said, by careful attention to arrangement of components, without sacrifice of external dimensions. In addition, controls are undisturbed, and belt tensioning is automatic and immediate. These features combine to make the belt-changing operation quick and easy.

The control design is of special interest since the actuating force is directed through an "equalizer" which prevents any binding or sticking of the speed control function. Control location is flexible and capable of quick relocation in the field to meet changing customer requirements.

The new drives are being offered from ¼ through 25 hp, a-c in output speeds from 5 to over 4000 rpm, with standard speed variations of 2, 3, 4, 5 to 1. Maximum speed variation (ranging from 6/1 at 25 hp to 10/1 at one hp ratings and below) is also available.

Accessories include remote mechanical, remote electric and pneumatic actuated controls. Remote electric speed indication systems, available in standard accuracies of 2 per cent and 3 per cent full scale, feature the new General Electric DO-91 panel instrument, DB-18 instrument and an a-c tachometer generator especially adapted for the new drives.



BLOOM BURNERS heat this huge continuous Tin Plate annealing furnace at Weirton Steel Company.

For 25 years . . .

BLOOM ENGINEERING LEADERSHIP

has brought about better and more efficient industrial furnace operation. Through the correct application of Bloom burners, combustion practice is improved and fuel costs reduced.

BLOOM ENGINEERING COMPANY, INC.

857 W. NORTH AVENUE • PITTSBURGH 33, PA.

SAFE!
DEPENDABLE!

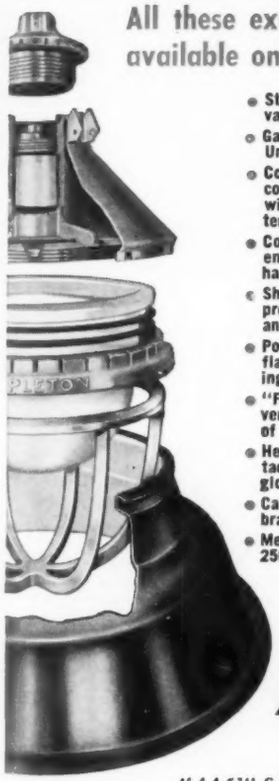
More Light!

Lower Operating Cost!

APPLETON®

MERCURY VAPOR Explosion-Proof Lighting Fixtures for Hazardous Areas

250 Watt conforms to requirements for Class 1, Groups C & D Hazardous Locations
... 400 Watt conforms to requirements for Class 1, Group D Hazardous Locations.



All these exclusive features available only with APPLETON

- Standardized Unilet Body permits a variation for mounting of fixture
- Gasket forms a positive seal between Unilet body and dome unit assembly
- Connecting Block houses recessed contact springs through which line wires are connected with screw terminals
- Collector Ring and Center Stud are energized after five full threads have been encased
- Shock Absorbing "Lamp-Lock" Socket prolongs lamp life with its resistance to shock
- Porous Metal Cylinder serves as a flame arrester and permits breathing of fixture
- "Full-Circle" Venting acts as a louver to aid in an even distribution of heat
- Heat and Impact Resisting Globe detaches itself from fixture when globe ring is unscrewed
- Cast Aluminum Guard has six sturdy braces for fixture protection
- Mercury Vapor Fixtures available for 250 and 400 watt lamp sizes

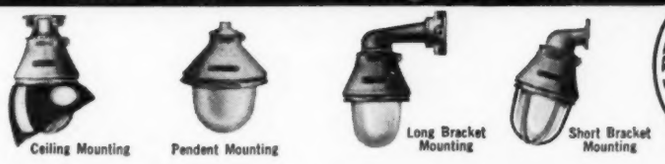
■ Enjoy 2½ times as much light with maximum protection against burn-out, and benefit from lowest possible operating cost by installing APPLETON Mercury Vapor Lighting Fixtures! Where millions of dollars in capital investments are involved in oil refineries, chemical plants, coal mines, grain elevators, paint factories and other types of businesses with hazardous areas, explosion-proof, mercury vapor lighting is worthy of the most serious consideration. In these "AA-51" Series Vented Fixtures you get all the benefits of proven APPLETON design and sturdy, vibration-proof construction resulting from years of pioneering effort. Investigate APPLETON ... the complete, interchangeable line that offers the maximum in protection, as well as a full complement of accessories including mountings, reflectors, and allied equipment. Write for full details!

Mercury Vapor Lamps:
250 watt—C-H5 Clear
—D-H5 Color Corrected
400 watt—E-H1 Clear
—J-H1 Color Corrected
—S-H1 Silver White

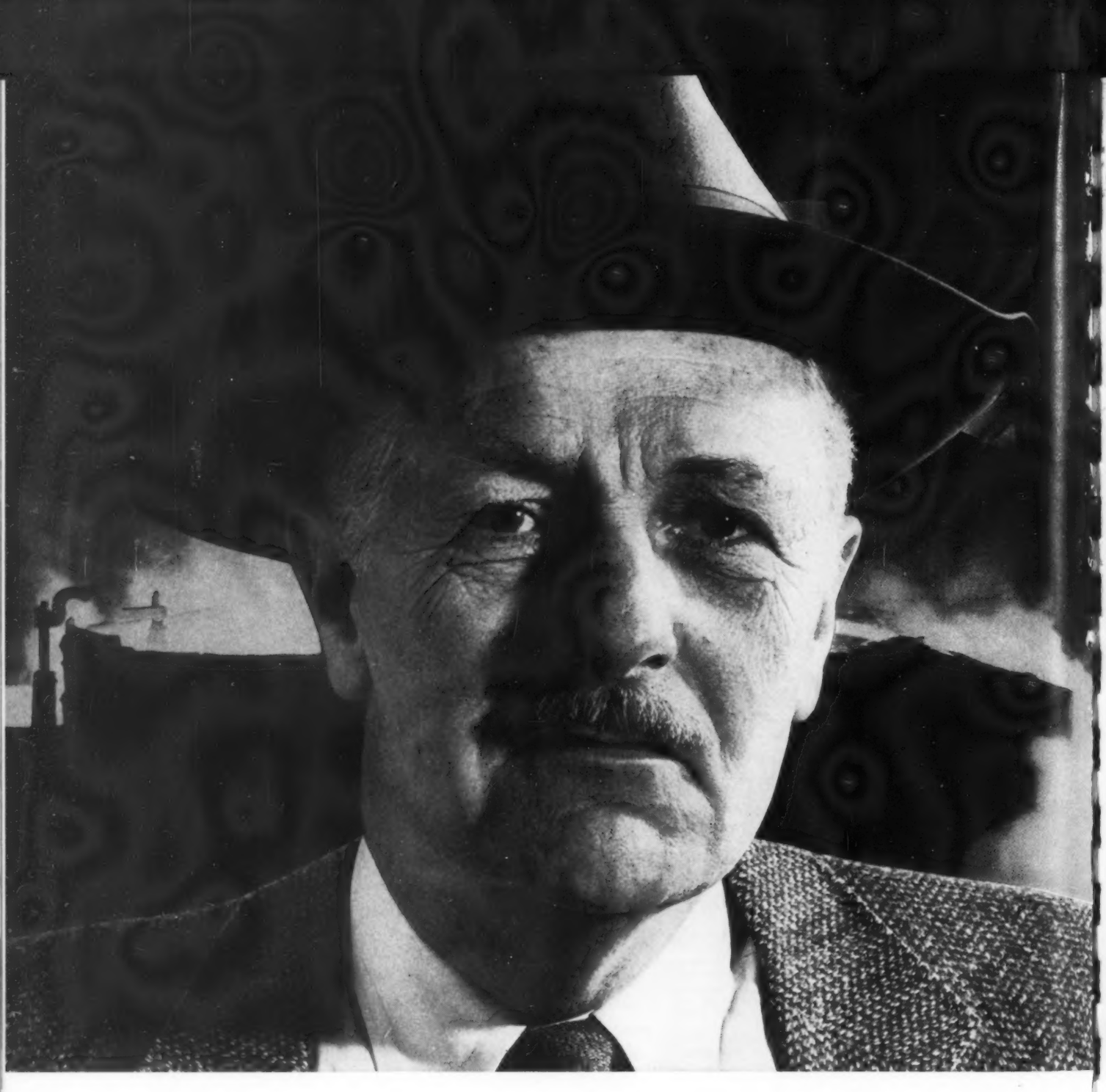
Sold Through Franchised Distributors Only

APPLETON ELECTRIC COMPANY
1701 Wellington Avenue • Chicago 13, Illinois

Additional Types of "AA-51" Series Explosion-Proof Lighting Fixtures



APPLETON ELECTRIC PRODUCTS®



"We've practically eliminated off-grade heats with MANTEMP ferromanganese"

An almost foolproof way to hit open-hearth manganese specifications consistently is with ladle additions of MANTEMP ferromanganese. Mill superintendents have reported that the alloy yields high recoveries and allows substantial reductions in overall ingot costs.

Fine grain size specifications can also be met easily because MANTEMP ferromanganese does not preferentially oxidize separately added aluminum. The alloy is available in both high- and medium-carbon grades, packed in cans containing exactly 40 pounds of manganese.

UNION CARBIDE METALS COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

For further information, write for this new six-page MANTEMP ferromanganese bulletin.

UNION CARBIDE METALS

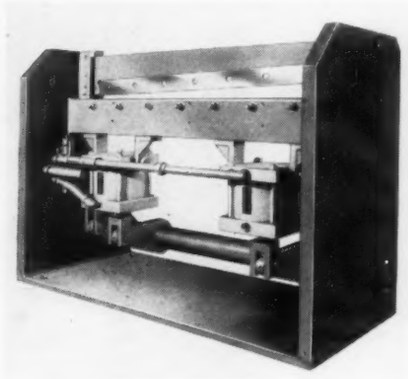
Electromet *Brand Ferroalloys and other Metallurgical Products*

The terms "Mantemp," "Electromet," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

STRIP SHEAR

△ A new down-cut strip shear operated by air pressure has been developed by Curry Air Shear Corp. Designed for cutting strip from 24 in. to 84 in. in width, the shear is effective on material up to $\frac{3}{16}$ in. in thickness. It is produced in a series of sizes to suit customer's requirements.

The shear operates from plant air supply or from an air compressor, on any air pressure from 60 to 100 psi. The unit is supplied complete



with air filter, air lubricator, muffler and self-contained hydraulic shock cylinder.

The shear illustrated measures only 64 in. x 30 in. x 3 ft-10 in. high, requires no foundation, and requires practically no maintenance over long periods of operation.

MOTOR CONTROLLERS

△ Two classes of new oil immersed, explosion-proof, corrosion-resistant, weather - proof, 2000 – 5000 - volt starters designed for hazardous and semi-hazardous locations have been announced by Allis-Chalmers Manufacturing Co.

These NEMA Class E1 starters are rated at 50-mva interrupting capacity and provide built-in short circuit protection to a motor on systems having a maximum of 50-mva capacity.

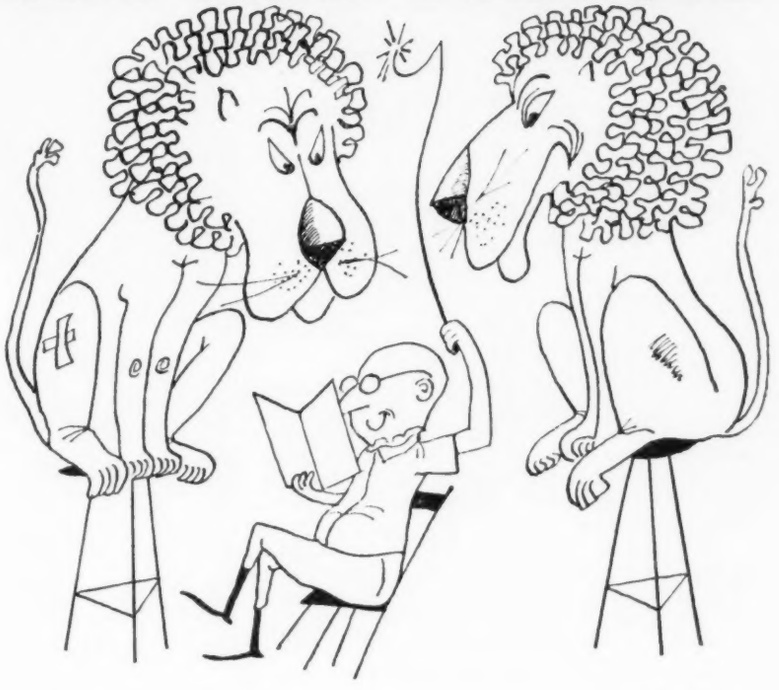
The starters are available in a floor-mounted lift-out type with all components immersed in oil (Class 5911) and in a frame-mounted tank lowering type with high voltage components immersed in oil and the low voltage control components mounted in explosion-proof air boxes (Class 5912).

Heart of the new starters is the heavy-duty oil-immersed d-c magnet-operated contactor (Type 426) rated 400-amp, 50-mva, interrupting capacity, 5 kv maximum.

Basic design features of the new starters include a recessed permanently clear oil level sight gage protected against external damage; segregated high and low voltage panels and components; heavy corrugated oil tank; stainless steel cover hardware; grounded center tap (110 volts) of the 220-volt circuit; accurate, adjustable over-current relays for short circuit protection; domed head for fast runoff of water and corrosive liquids, and a $\frac{3}{4}$-in. drain valve extended to the front of the tank from the center of the bottom.

The contactor cover with high and low voltage panel of the floor-mounted lift-out type can be easily raised by one man for inspection as one unit with a portable kit type lifter without disconnecting any leads. The lifted height of the contactor is ideal for servicing from ground level, and positive pins hold the contactor and cover safely

ONE MAN CONTROL



G-A *Cushioned* Flowtrol Valve

It's easier to operate a G-A Flowtrol Valve than it is to drive a car with power steering! The reason? Line pressure furnishes the power to open or close the valve. No manual effort, no handwheels, no motors, no levers are needed —regardless of size of valve or pressure. Just a "flick of the wrist" or press of a button will fully open or tightly close the valve.

Get all the facts in Bulletins W-8A and G-4.

GOLDEN ANDERSON Valve Specialty Company

1220 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

in the raised position for inspection and servicing.

In the frame-mounted tank-lowering type contactor, the portable lifter is quickly attached to the unit for tank lowering without the need for disconnecting any leads.

Complete information giving construction, test results, and specifications for the new starters is contained in a four-page bulletin which includes outline dimensions for the units.

REFRACTORY

△ A new castable refractory, Plicast K-L Mix, has recently been announced by Plibrico Co. Recommended for a wide range of general applications, the chief characteristics of this product are its high service temperature limit and its resistance to the most severe abrasion and chemical attack.

It has exceptional strength that develops early in, and runs uniformly through its entire broad temperature range which extends from 200 to 3000 F.

The material has a fusion point of P.C.E. Cone 36 (3280 F). To place one cubic foot requires 125-lb and the product is packed dry in 100-lb bags. Mixed with water on the job, it can be poured or trowelled, and sets hydraulically. A separate formulation, Plicast K-L Mix G, is available for pneumatic application.

VALVES

△ DeZurik Corp. has announced the availability of their eccentric valves with plastic coatings. The coatings greatly improve the corrosion resistance of a cast iron valve at only a slight increase in price, the company stated.

The plastic coatings make the valve especially suitable for neutral

salt solutions, alkalies, alkaline salts, mild acids and many other services. They are also an economical answer to iron contamination in water distillation, demineralization and deionization systems.

The valves work on an eccentric principle which pivots the plug eccentrically in the valve body to an eccentrically-raised seat. The plug touches the valve body only when the valve is closed. Plug friction is completely eliminated. Their resilient faced plug eliminates the need for lubrication to achieve tight shutoff.

PORTABLE METER

△ A new portable eddy current instrument has recently been added

in furnace lining...

Plicast Monolithic Castables

better 4 ways

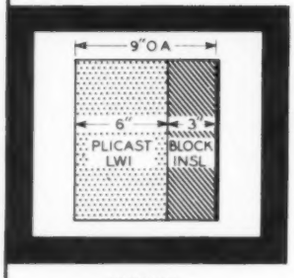
Study was made using special and ordinary linings in a car type annealing furnace operating at an inside temperature of 1800° F. Plicast LWI Insulating Castable and fire brick were compared to determine the hourly heat loss and heat storage capacity for each square foot of furnace wall.

1 **Heat loss 33% less . . . heat storage capacity 91% less with Plicast.** Outcome of the test illustrated to the right shows savings gained using lighter two-component wall poured with Plicast LWI Castable backed with block insulation.

2 **Cost of operating furnace much less with Plicast.** In this test $1,380 (14%) was saved in fifty weeks operating a car type furnace with a wall area of 300 square feet 8 hours daily, 5 days a week.

3 **Less material and maintenance needed with Plicast.** These results were obtained with one-third less refractory material in the walls and arch.

4 **Larger furnace capacity with Plicast.** The thinner walls added 6 inches in width, 3 inches in depth and height to the inside dimensions.

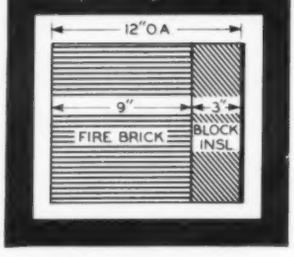


PLICAST
Heat storage: 3,650 btu/sq. ft.
3,650 btu=3.6 cu. ft. gas
or: .025 gal. oil

Heat loss: 180 btu/sq. ft.
(still air at 70° F.)
180 btu=.180 cu. ft. gas
or: .0012 gal. oil

FIRE BRICK
Heat storage: 42,000 btu/sq. ft.
42,000 btu=42 cu. ft. gas
or: .29 gal. oil

Heat loss: 270 btu/sq. ft.
(still air at 70° F.)
270 btu=0.263 cu. ft. gas
or: .0019 gal. oil



Write for Case Study Report giving complete data on 4-way savings or call your local Plibrico man to see how much you can save on your refractory lining.

Plibrico REFRACTORIES

PLIBRICO COMPANY, 1804 Kingsbury, Chicago 14

Plibrico Sales & Service in Principal U. S. Cities & Canada

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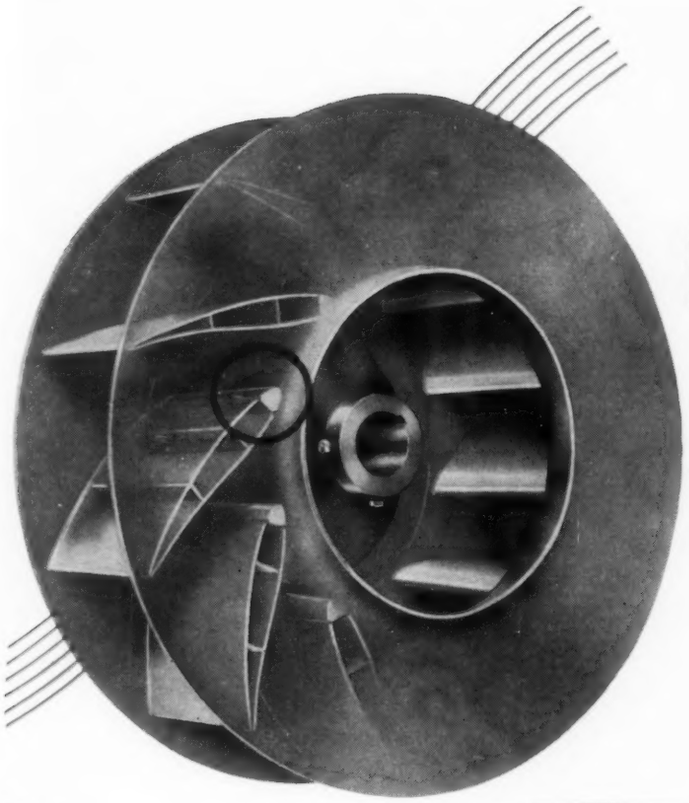


COSTS HELD DOWN WHEN INLAND® INCLUDED

Green Airfoil Fans

IN FURNACE REBUILDING

At their #2 plant in East Chicago, Indiana, Inland Steel completely rebuilt and enlarged their furnaces to increase production. These rebuilt furnaces called for greater induced draft capacity in the waste heat boilers. The old fan installation of 7 Green radial blade fans had been installed 24 years ago.

Inland Steel replaced these 7 Green fans with 7 Green AIRFOIL induced draft fans. No changes were made in the original motors or electrical system. The 7 Green AIRFOIL fans took care of the increased draft requirements without overload on the original 125 hp motors.

In short, the new Green AIRFOIL fans made it possible for Inland Steel to increase the size and capacity of their furnaces without the expense of new motors and electrical installations in addition.

The Green AIRFOIL design provides smooth airflow with a minimum of turbulence. For longer life, the AIRFOIL fan blades have specially designed cast steel nose pieces to reduce wear. (See circled nose piece in illustration.)

If you have a tough job for heavy duty fans, it makes sense to talk over your problem with Green.

Green

THE GREEN FUEL ECONOMIZER CO., INC.,

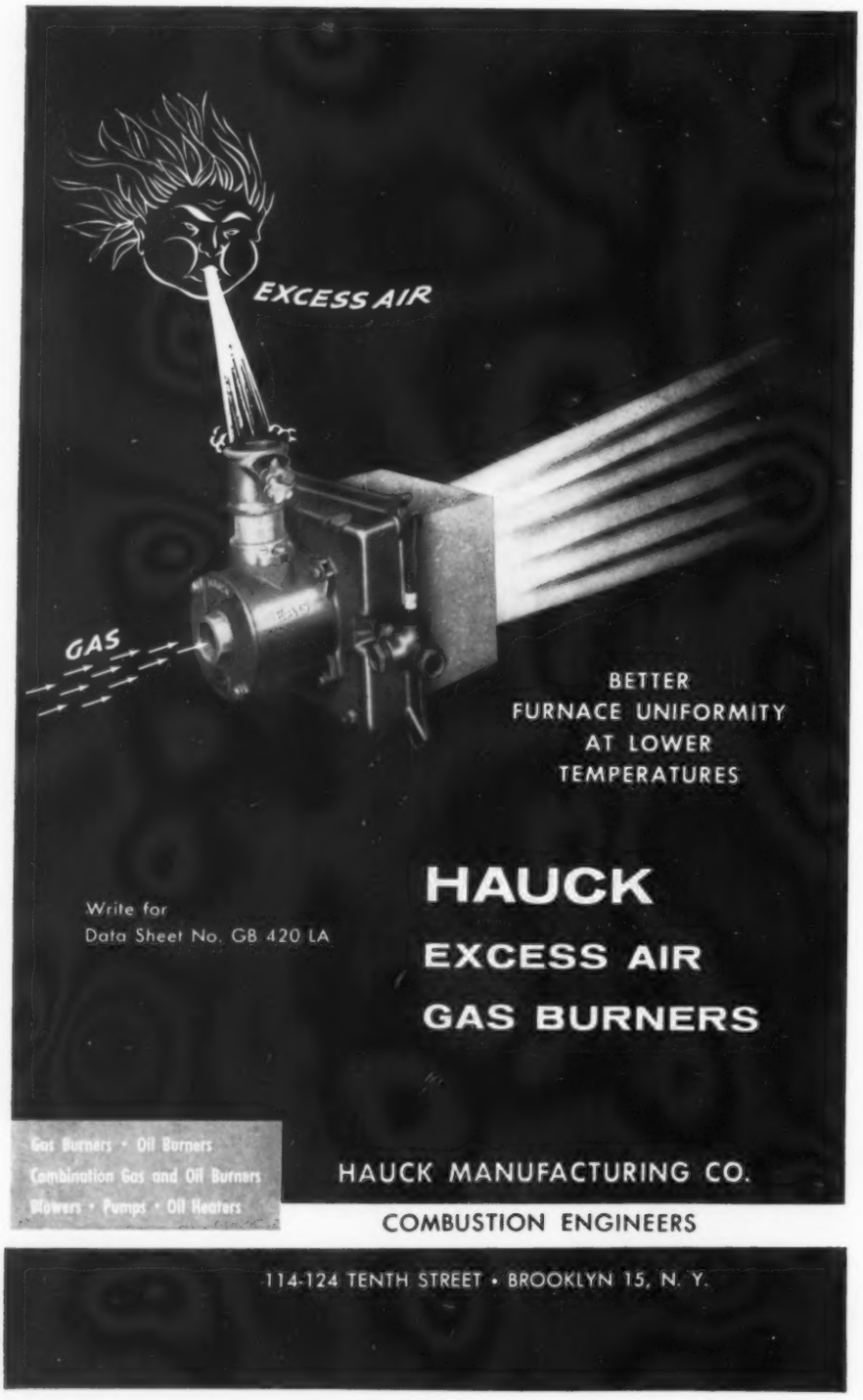
BEACON 3, NEW YORK

to the group of testing systems available from Magnaflux Corp. By accurately measuring electrical conductivity, the battery-powered Magnatest FM-110 Conductivity Meter performs a variety of testing jobs, including the determination of hardness, alloy and heat-treat condition, sorting mixed nonmagnetic metals and many others. Readings can be taken on a comparative basis using known samples, or in absolute electrical conductivity units as a per cent of the International Annealed Copper Standard.

The FM-110 induces eddy currents within the test piece by means of a ½-in. diam hand-held probe. These currents affect the impedance of the probe coil as a function of the conductivity of the material. With the probe on one side of the test piece, the large knob is turned to zero the meter and conductivity is read on the left-hand scale.

This compact 3⅜ x 8¾ x 6½ in. instrument, weighing only 4½ lb can be used for both production and on-site testing. Total range is 8 to 107 per cent I.A.C.S., with an accuracy better than ±3 per cent of scale reading, and usually better than ± 1 per cent when used on a comparative basis.

Three volts from two standard flashlight batteries power the self-contained unit. A built-in battery checker indicates whether the batteries meet the required operating voltage range.



PURE MAGNESIA CERAMIC

△An extremely pure magnesia ceramic capable of long-term operation at temperatures up to 4350 F has been developed by Corning Glass Works.

The dense, nonporous material is 99.8 per cent pure magnesia. A uniform, fine-grained structure gives it a flexural strength of 15,500 psi at room temperature.

Magnesia is among several high-temperature Corning ceramics. They are suitable for a variety of refractory and electrical applications.

The magnesia ceramic can be slip-cast, pressed or extruded into a variety of shapes.

Melting point of the magnesia is over 5000 F and it possesses the thermal characteristics of an ablating material. It is high-fired during forming to eliminate shrinkage.

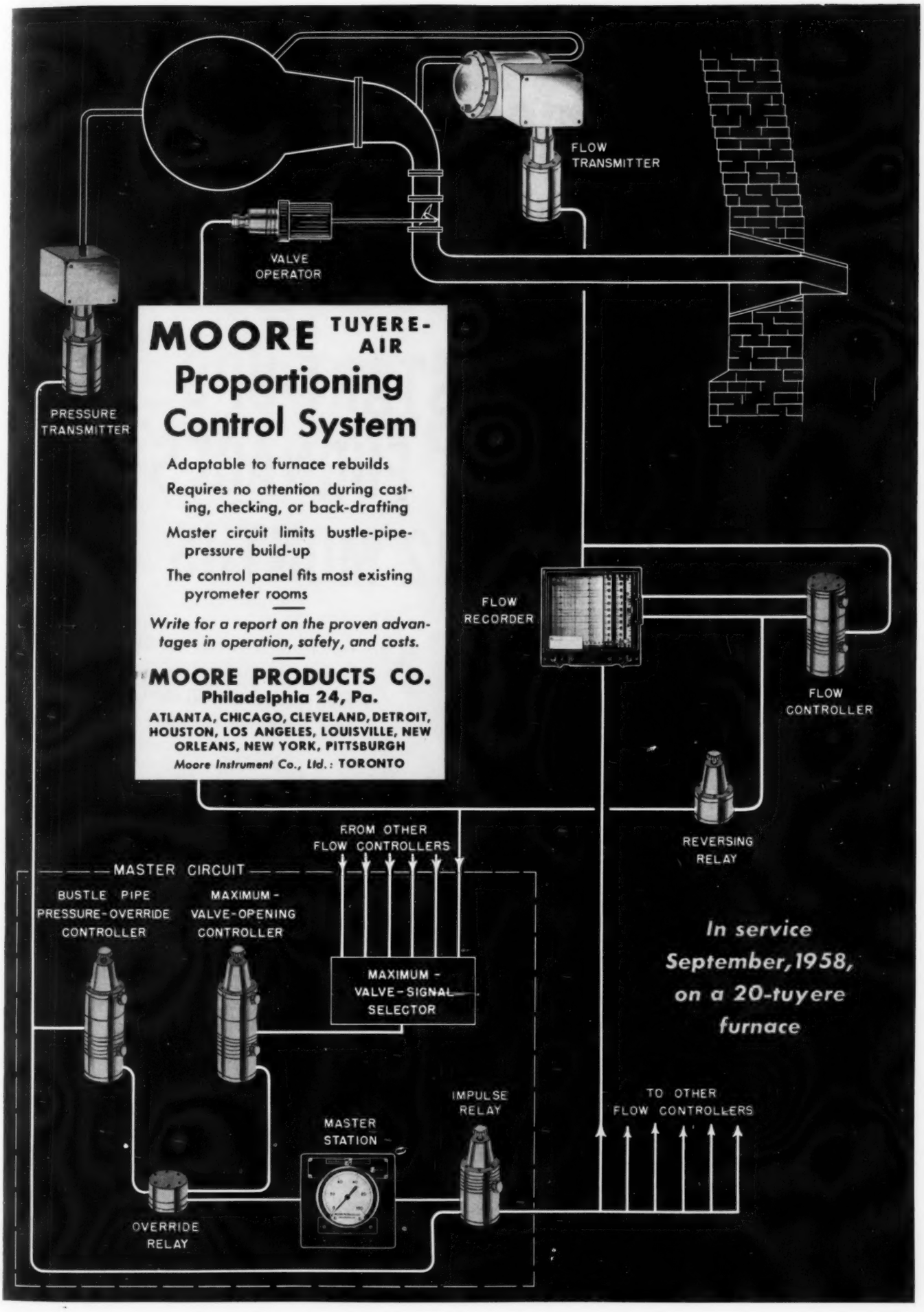
FLOWMETER

△The search for a practical industrial instrument to directly measure liquid and gas flow in pounds has resulted in development of a "true mass" flowmeter, according to a joint announcement by General Electric Co. and Black, Sivalls and Bryson, Inc.

The simple, low-maintenance device precisely measures the weight of flowing fluids with high accuracy over wide ranges of flow rate, pressure, temperature and density.

It does this without additional measurements and corrections for these variables, the announcement said.

First production units of the General Electric instrument—expected to be available early in 1960—will meter many industrial fluids including naphtha, gasoline and other hydrocarbon liquids, refinery and natural gas, oxygen and nitrogen, and liquefied hydrocarbon


FLOW TRANSMITTER
VALVE OPERATOR
PRESSURE TRANSMITTER
MOORE TUYERE-AIR
Proportioning Control System
Adaptable to furnace rebuilds
Requires no attention during casting, checking, or back-drafting
Master circuit limits bustle-pipe-pressure build-up
The control panel fits most existing pyrometer rooms
Write for a report on the proven advantages in operation, safety, and costs.
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Philadelphia 24, Pa.
ATLANTA, CHICAGO, CLEVELAND, DETROIT, HOUSTON, LOS ANGELES, LOUISVILLE, NEW ORLEANS, NEW YORK, PITTSBURGH
Moore Instrument Co., Ltd.: TORONTO
FLOW RECORDER
FLOW CONTROLLER
REVERSING RELAY
FROM OTHER FLOW CONTROLLERS
MASTER CIRCUIT
BUSTLE PIPE PRESSURE-OVERRIDE CONTROLLER
MAXIMUM-VALVE-OPENING CONTROLLER
MAXIMUM-VALVE-SIGNAL SELECTOR
In service September, 1958, on a 20-tuyere furnace
IMPULSE RELAY
TO OTHER FLOW CONTROLLERS
MASTER STATION
OVERRIDE RELAY

CHEMICO VENTURI WASHERS... ELEVEN TROUBLE-FREE START-UPS ON BLAST FURNACES IN PAST 12 MONTHS

High operating efficiency and proven reliability are the two features which set Chemico Venturi Washers apart. In the last twelve months alone, Venturi equipment was installed in eleven blast furnaces with no start-up difficulties whatsoever. In addition, all eleven units exceeded their performance guarantees. Here are five reasons for this outstanding record:

- Standardized design permits efficient scale-up for any size furnace
- Wear-proof materials insure maintenance-free operation for *more* than furnace campaign
- Design includes complete flexibility to handle any blowing rate
- Simple maintenance-free water injection nozzles
- Newly developed high efficiency entrainment separator

Write today for further details from Chemico!

CHEMICO

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gases such as butane and propane.

Black, Sivalls and Bryson, Inc. will market the flowmeter in the natural gas industry, Edwin E. Parker, general manager of General Electric's Instrument Department said.

He added that B S & B cooperated with General Electric in the development of the meter and handled its proving out for measurement of natural gas.

Pointing up the significance of the new device, Mr. Parker noted that the pound is a fundamental fluid measurement unit used by many industries as a basis for figuring costs, regulating blending operations, measuring yields, determining energy or Btu content, or metering bulk loading operations.

However up to now, commonly used methods of determining fluid flow by mass have first required a measurement of fluid volume.

This volume must be either manually or automatically corrected for such variables as fluid temperature, pressure and density to determine pounds.

Manual methods are cumbersome, time consuming and leave room for human error. Automatic correction systems are relatively complex and present additional maintenance problems.

In contrast the flowmeter—sensing mass directly—requires no in-between calculations is completely self-contained weighing about 100 lb, and is designed for long, maintenance-free operation.

This inherent simplicity and the high accuracy (plus or minus one per cent of reading) of the flowmeter under changing conditions make the instrument ideal for those applications where fluids are or should be measured by weight.

Commenting on the importance of the instrument to the natural gas industry, Kenneth W. Lineberry, president of B S & B said, "The mass flowmeter will provide the industry with a means for absolute flow measurement with sustained high accuracy. It will reduce the expense involved in the computing operations required in measurement by volume."

The flowmeter is also compatible with automation, being designed to emit a series of electrical pulses, each representing a given weight of fluid. This signal can be used to operate auxiliary equipment such as remote counters, printers and totalizers.

Looking beyond present applications, Mr. Parker indicated General Electric is continuing development work to adapt the basic flowmeter to measurement of other gases and liquids.

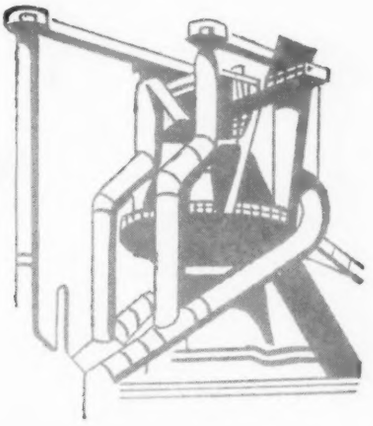
These are expected to include light gases such as hydrogen and helium as well as high-temperature, corrosive and cryogenic (low temperature) fluids—steam, acids and liquid oxygen for example.

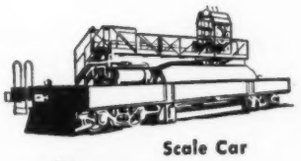
Several basic contributions to flowmeter technology are incorporated in the instrument. One is a small gyroscope which directly and automatically totalizes flow in a novel manner. Another is a flow-rate sensor, common to flowmeters developed and produced by General Electric since 1953 for measuring aircraft fuel consumption. It consists of a constant-speed impeller and a stationary turbine arranged for axial flow.

The impeller gives a twist to the fluid stream and the fixed turbine straightens the stream. The amount

(*Please turn to page 216*)

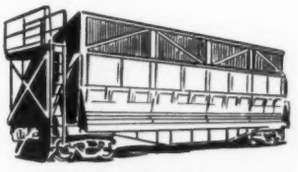
WHEREVER *performance* **COUNTS**





Scale Car

100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

Each car is engineered to meet the operating needs of the plant where it will be used.

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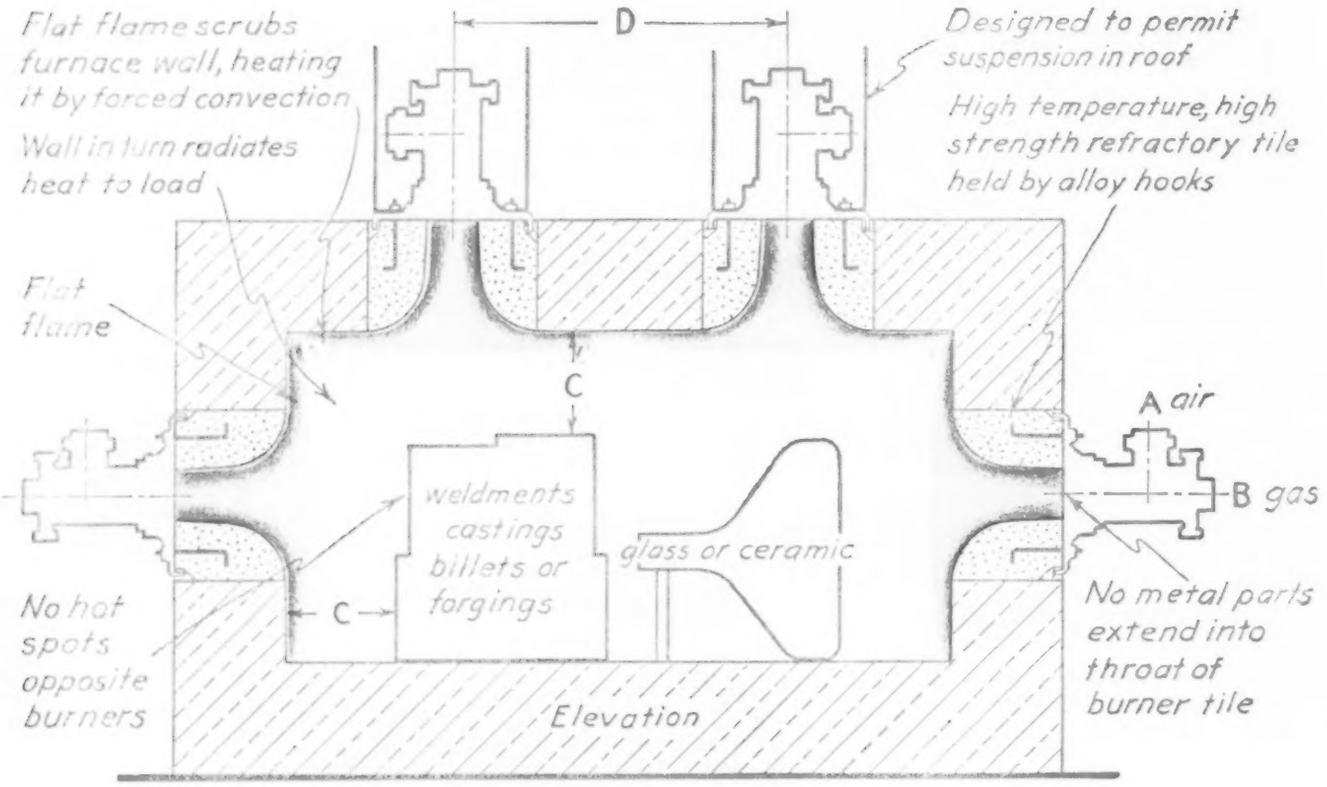
Consult Atlas for your Steel Plant Cars

ENGINEERS AND MANUFACTURERS SINCE 1896

Put Your Furnace Walls and Roof to Work with
North American FLAT FLAME BURNERS

More Production — No Hot Spots


Flat flame scrubs furnace wall, heating it by forced convection
Wall in turn radiates heat to load
D
Designed to permit suspension in roof
High temperature, high strength refractory tile held by alloy hooks
Flat flame
C
A air
B gas
weldments castings billets or forgings
glass or ceramic
C
No hot spots opposite burners
No metal parts extend into throat of burner tile
Elevation

This Sketch shows how your North American Combustion Engineer might suggest using Flat Flame Burners to get the fullest use from your furnace — by putting a bigger pay load closer to walls and roof without flame impingement. (Figures for typical applications are listed in the table below.)

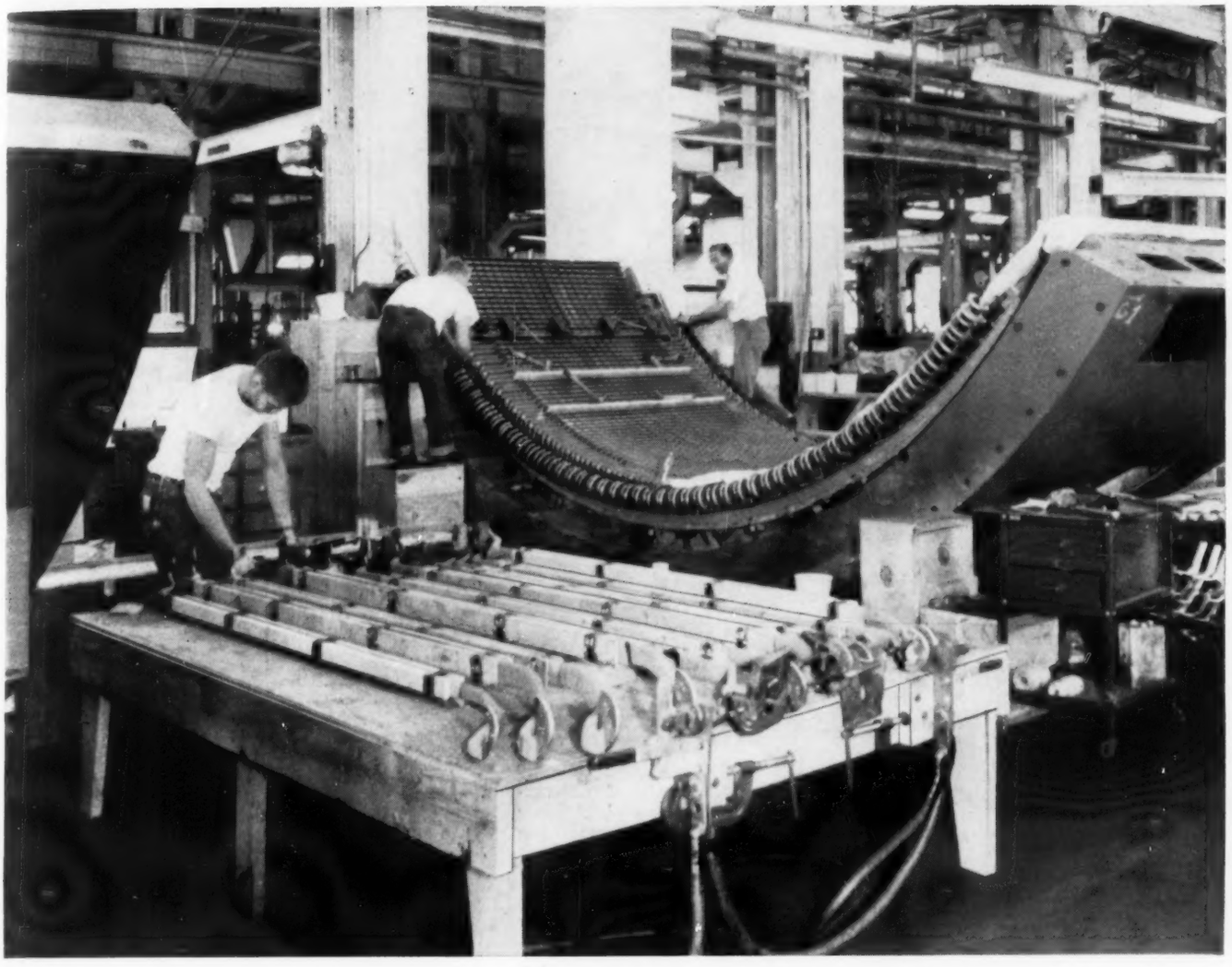
Each flame actually turns the corner of its specially shaped tile to give a temperature uniformity never before possible with so few burners. These nozzle-mix burners have an exceptionally wide turndown range and can be operated on correct air-fuel ratio or with excess air.

BURNER	A, Air Pipe Size	B, Gas Pipe Size	C, Suggested Min. Wall to Load	D, Suggested ℄ to ℄		Specifications
				Minimum	Maximum	
4832-2 & 4836-2	1¼″	1″	9″	13½″	30″	
4832-3 & 4836-3	1½″	1″	9″	16″	36″	Series 4832 has a 13½″ square tile.
4832-4 & 4836-4	2″	1¼″	9″	18″	48″	
4832-5 & 4836-5	2½″	1½″	11″	24″	62″	Series 4836 has a 24″ square tile.
4832-6 & 4836-6	3″	2″	12″	27″	77″	
4832-7 & 4836-7	4″	2½″	14″	33″	100″	

For engineering information, call your nearby North American Combustion Engineer or write for bulletins

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
Cleveland 5, Ohio



King-size rebuilding job by National

...*The* Specialists in electric coils...repair service

Severely damaged by fire, this 30,000 kva generator required complete rebuilding. Since the fire had warped the stator, it was shipped to National Electric Coil's Columbus plant, where the first job was to remove the laminations and straighten the frame. Damaged laminations were replaced with new ones and the core restacked. Coils, manufactured by National, are shown in the illustration being wound into a section of the stator which was of such size that it was built in thirds to make rail shipment possible.

After thorough testing, the stator was shipped back to the customer, assembled on the site, and the winding lap between each of the sections completed.

Whenever you need service on rotating electric machinery—whether large or small, whether you need a few coils or a complete rebuilding job—contact National Electric Coil. Our service is fast, thorough and guarantees satisfaction.

For more information in the next 2 minutes call National's Columbus plant . . . HUdson 8-1151. Or call the nearest National field engineer.

National Electric Coil

DIVISION OF McGRAW-EDISON COMPANY

COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

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Complete Electric Furnace Service

by American Bridge, exclusive manufacturers of the Heroult Electric Furnace

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From foundation to furnace, from engineering to erecting, American Bridge is prepared to install a modern, efficient Heroult with minimum inconvenience to your operations.

2. Furnace modernization

American Bridge is prepared to modernize your old Heroult Furnace by installing improved new mechanisms that will increase the efficiency and productivity of your unit.

3. Prompt part replacement

If you own a Heroult (regardless of age), American Bridge is prepared to replace any of its parts. More common parts are carried in stock, others will be made to order. But in either case, we are prepared to give fast service.

For more information, contact our office nearest you

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ROLLWAY MAXIMUM BEARINGS

. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

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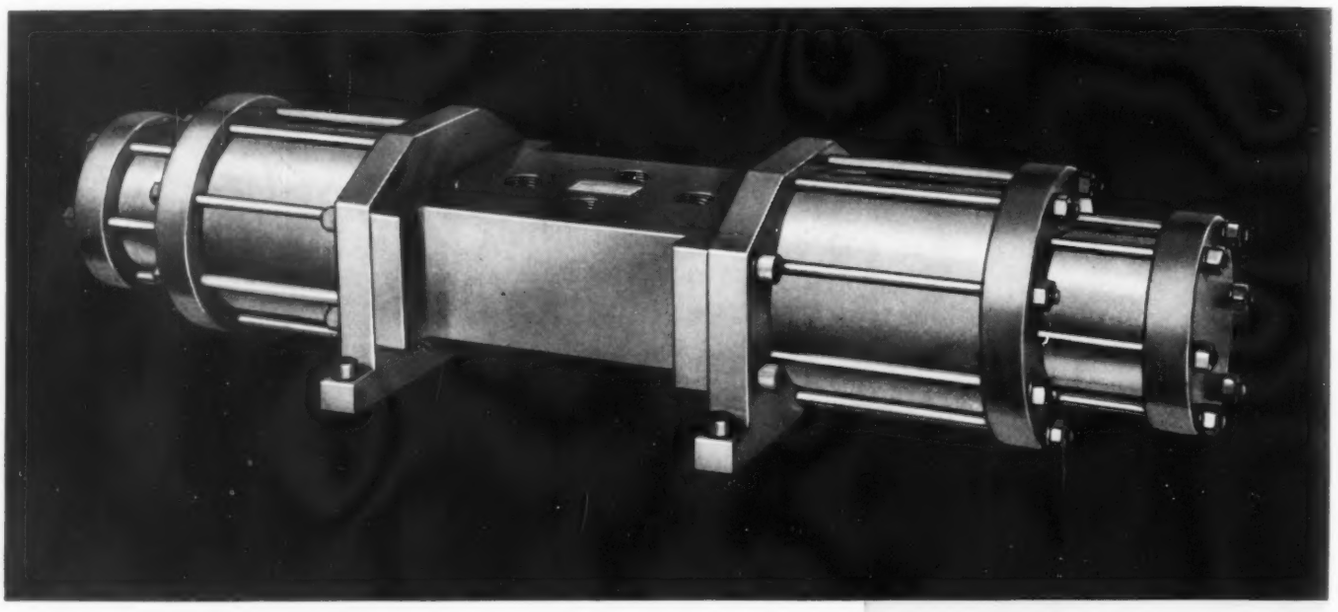
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

HUNT
HYDRAULIC VALVES

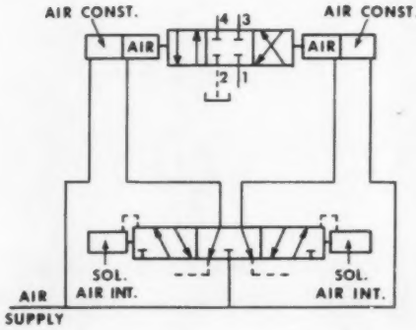
First Choice in the Steel and other Heavy Industries



Here's Why!

Over 20 years of specialized experience designing—and building—hydraulic operating valves for rugged industry requirements . . . ½" to 8" sizes . . . Zero leakage on water, soluble oil and water, or oil . . . Valves to meet any application . . . No metal to metal seating . . . Easy field maintenance . . . Inexpensive maintenance parts . . . For utmost dependability and service call the Hunt man.

1½" Three Position 4-way Air Pilot Operated 2000 p.s.i. Valve for Oil or Water Service. Other Designs to 5000 p.s.i. Control Circuit Diagram Below Shows Automatic Return to Mid Position.



More startling HUNT designs to come!

40 1919 1959 YEARS of Service

HUNT

Quick-As-Wink*® AIR AND HYDRAULIC CONTROL *Valves

Manufactured by HUNT VALVE COMPANY, 1922 East Pershing St., Salem Ohio

THE ENGINEERING MART

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AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

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Equipment News

(*Continued from page 209*)

of torque exerted on the turbine when removing the twist is proportional to the mass rate of flow.

The gyro integrates this torque with respect to time, and the output is continuously summed up on a cyclometer dial in pounds.

It was explained that a marked advantage of this system is its ability to operate from an unregulated power supply without any measurable effect on meter accuracy.

Book Reviews

"**The Nimonic Alloys**" by Dr. W. Betteridge has been published recently by St. Martin's Press, 103 Park Avenue, New York 17, N. Y. The book contains 332 pages, 6 x 9 in., is cloth bound, and sells for $15.00. The information contained in this book deals mainly with metallurgical characteristics and mechanical and physical properties, as well as suitable methods of treatment and manipulation of the alloys; manufacturing and processing techniques, and the fundamental factors which are responsible for the particular characteristics of the alloys have been discussed only briefly, when they are relevant to properties and uses. The presentation is concise and logical in manner; line drawings, graphs, tables, and photographs are used to substantiate and illustrate the text.

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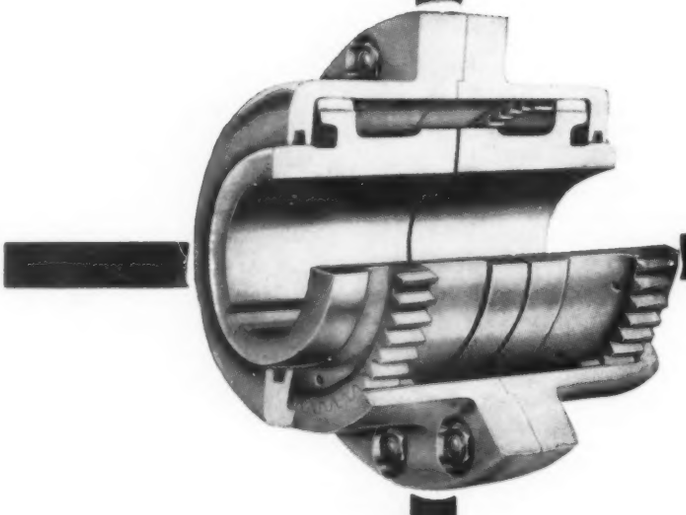

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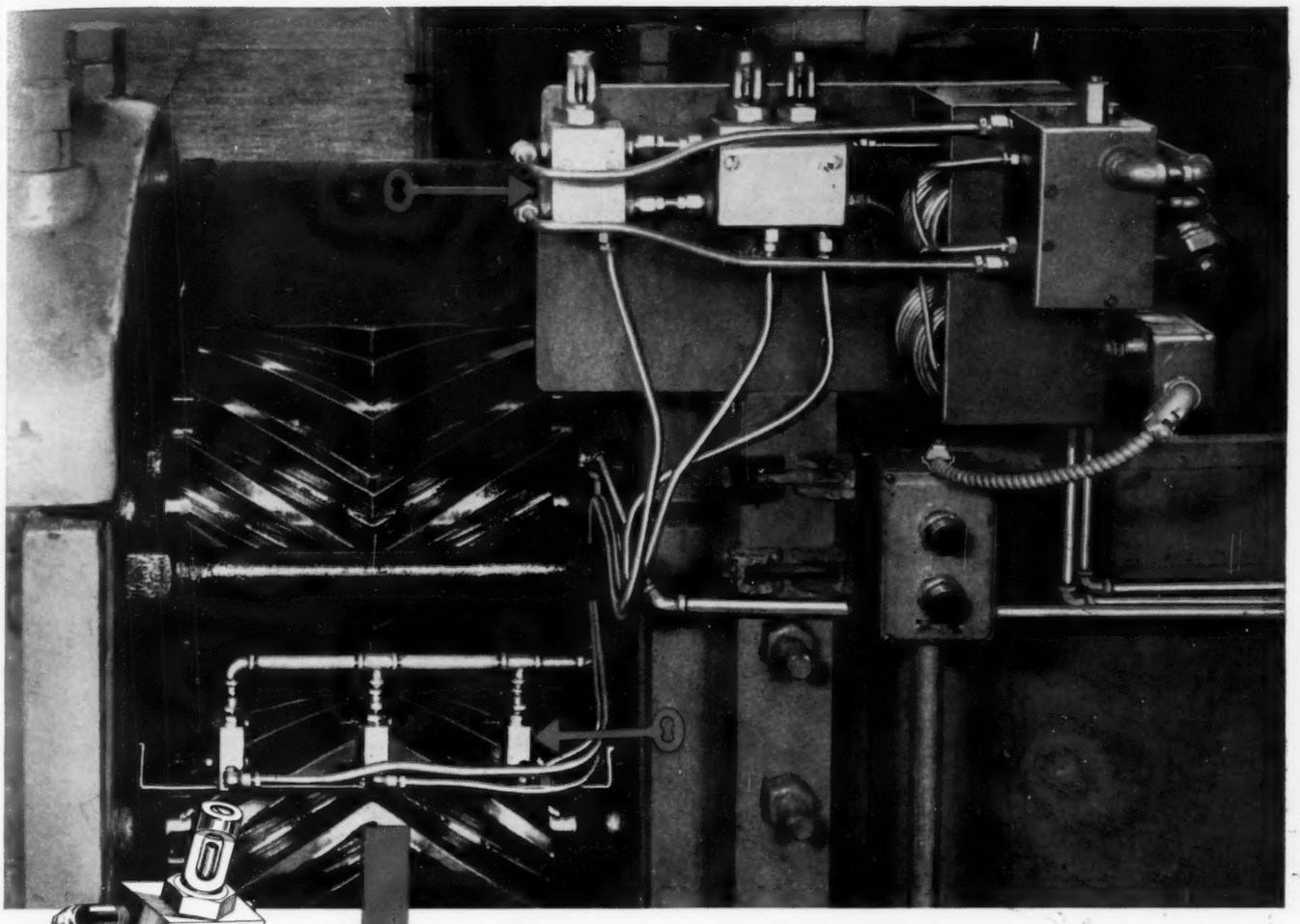

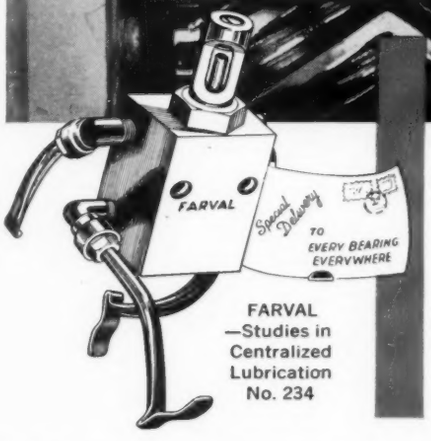

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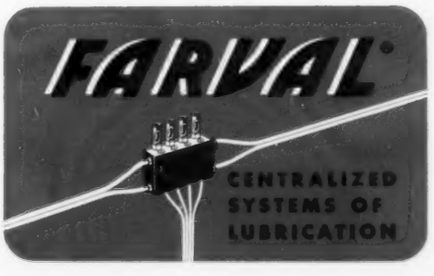

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